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Evaluation of Methods Used to Desorb the Constituents
Adsorbed on the Charcoal Contained in Automotive
Evaporative Canisters. Part 2

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EVALUATION OF METHODS USED TO DESORB THE CONSTITUENTS
CONSTITUENTS ADSORBED ON THE CHARCOAL CONTAINED IN
AUTOMOTIVE EVAPORATIVE CANISTERS - PART II

by

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ABSTRACT

This report presents the conclusion of a two-part study which evaluated current extraction methods for analyzing charcoal canisters used to control evaporative emissions in automobiles. The second part of this study investigated the use of solvent-free extraction methods such as high pressure CO₂ soxhlet extraction and vacuum transfer extraction. The results of the solvent-free methods were then compared to the CS₂ soxhlet extraction method.

The results of this study showed that the CS₂ method extracted up to 8% more material (by weight) from the charcoal than did the vacuum transfer method and up to 15% more material (by weight) than did the high pressure CO₂ soxhlet extraction method. In addition, more total hydrocarbons were measured with the CS₂ method than were measured in either the vacuum transfer or the high pressure CO₂ methods.

The vacuum transfer apparatus used for this study was a modification of the apparatus that had been used for a previous study. More of the higher molecular weight hydrocarbons, mainly alkylated aromatics greater than carbon number 9, were measured in the extracts obtained from the modified vacuum transfer apparatus than were measured in the extracts from the previous method. Lower quantities, however, of the lower molecular weight hydrocarbons were measured than before.

The high pressure CO₂ soxhlet extraction method gave the lowest hydrocarbon measurements of the three methods.

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SECTION 1

INTRODUCTION

The Atmospheric Research and Exposure Assessment Laboratory (AREAL) conducted a two-part study in order to determine the most accurate, practicable and cost effective method for evaluating charcoal canisters which are used to collect evaporative hydrocarbon emissions from gasoline powered vehicles. When the Manufacturers Operations Division (MOD) at EPA began testing vehicles to determine their compliance with the federal emission standard, a significant number of the vehicles failed to meet the evaporative hydrocarbon emission standard. The MOD suspected that these failures were caused by a decrease in the efficiencies of the charcoal canisters to capture hydrocarbon vapors. As an aid in their assessment of canister performance, MOD requested AREAL to determine the nature and quantity of the material adsorbed and retained on the charcoal contained in these canisters. One concern of MOD was that using the present CS₂ soxhlet extraction method in the analysis of the canisters might alter the quantity and type of hydrocarbons or other materials desorbed from the canister's carbon. In addition, still unknown was which of the current methods of desorbing the hydrocarbon constituents from the carbon would be the most accurate, practicable and cost effective.

The first phase of this study involved the use of various solvents or a combination of solvents to extract the charcoal in a soxhlet extraction apparatus. Ultrasonication of the charcoal with CS₂ as the solvent was also used. Solvent extractions are most

often the standard method to be compared with and usually provide an indication of the maximum amount of adsorbed material that can be extracted from the charcoal. On the other hand, solvent extraction introduces impurities, such as benzene from the CS_2 , and the potential for errors with many sample handling steps. In Part I of this study we showed that CS_2 was the most practicable solvent for the extraction and analysis of the charcoal. The total quantity of material soxhlet extracted from the seven charcoal samples analyzed was the same for the various solvents tested, except for methanol. CS_2 was the preferred extracting solvent because, in the GC/FID analysis of the CS_2 extracts, the CS_2 solvent peak only interfered with the measurement of the C_5 hydrocarbons. When using solvents such as CH_2Cl_2 or hexane, the solvent peak interfered with the measurement of the C_6 and C_7 hydrocarbons.

The second phase of this study was to investigate solvent-free extractions of the charcoal and included a modified vacuum transfer method and a high pressure CO_2 soxhlet extraction method. Microwave desorption, thermal desorption and super-critical fluid (using CO_2 under high pressure) extraction techniques would not be investigated because of lack of equipment and budget constraints.

Solvent-free extraction of the material from the charcoal was the preferred method because sample handling and the potential for heat induced artifact formation are minimized during the extraction process. In addition, solvent free extractions eliminate the solvent peak interference in the GC/FID measurement of the hydrocarbons in the extracts.

SECTION 2

CONCLUSIONS

The results from the second phase of this study show that, at present, the CS₂ soxhlet extraction method is the most practicable and efficient method for desorbing and analyzing the C₆+ constituents adsorbed on charcoal. This method, however, can only aid in determining the composition of the relatively higher molecular weight compounds on the charcoal, since the more volatile components are lost through the condenser system.

High pressure CO₂ soxhlet extraction is not a practicable method for extracting these charcoal samples because this method does not completely extract the material adsorbed on the charcoal. Moreover, the results showed that the lower molecular weight, more volatile, hydrocarbons were not retained in the extracts.

The modification of the vacuum transfer apparatus did not improve the method sufficiently to recommend this method for extracting charcoal over the CS₂ soxhlet extraction method. The modification did increase the extraction of the alkylated aromatic hydrocarbons. However, the quantities of the alkyl aromatics measured using this modified vacuum method were still lower than measured by the CS₂ extraction method. Lower quantities of the lower molecular weight hydrocarbons were found in the extracts with this modified apparatus than were measured by the previous apparatus.

SECTION 3

RECOMMENDATIONS

A mass balance involving the amount of material extracted and the quantity of hydrocarbons measured in the extracts cannot be attained with the CS_2 soxhlet extraction method. The vacuum transfer method, must be used to determine the quantity of the hydrocarbons less than C_6 adsorbed on the carbon. However, the vacuum transfer method is time consuming since it requires one day to extract and analyze each sample as compared to 6 samples per day for the CS_2 method. Further modification of the apparatus is needed to reduce or eliminate vacuum leaks which result in the loss of low molecular weight hydrocarbons. Two other charcoal extraction methods, thermal desorption and supercritical fluid CO_2 extraction, should be investigated, since these methods are solvent-free, require minimum sample handling, eliminate exposure to toxic CS_2 vapors, and might be more cost effective than soxhlet extraction with CS_2 .

SECTION 4

EXPERIMENTAL

Handling and Storage of Charcoal Canisters

The seven canister samples analyzed for this second part of the study were the same as those analyzed in Part 1. Five of the canister samples had been prepared and analyzed for previous canister studies. The other two canisters were taken from an in-house evaporative emission project where the loading and purging of the canisters had been done under controlled conditions. One canister was loaded with gasoline vapors from a base stock gasoline and was labeled gasoline-base. The other canister was loaded with gasoline vapor containing 10% oxinol (5% methanol + 5% t-butyl alcohol). The preparation and handling of the samples has already been described in Part 1. The two unused (blank) charcoal samples that were analyzed in Part 1 were analyzed in the initial set up of the high pressure CO₂ soxhlet and vacuum transfer methods. Only water was extracted from the blanks.

High Pressure CO₂ Soxhlet Extraction

A high pressure soxhlet extractor (J&W Scientific, Folsom, Calif.) was used to extract the charcoal (Fig. 1). CO₂ was used as the extracting solvent. The high pressure CO₂ extraction procedure used was the same procedure as described in the operating and supplementary instructions provided by J&W Scientific.

The charcoal sample (approximately 1.00g) was weighed into a preconditioned cellulose thimble and the thimble was then placed

into the soxhlet extractor. The soxhlet extractor was placed in a pressure chamber which was then sealed. The chamber and filling lines were then evacuated under moderate vacuum. After the inlet and outlet valves to the chamber were closed, the inlet lines were filled with liquid CO_2 and the lower part of the chamber was placed into a preheated (60°C) water bath. The chamber was immersed in the water bath for 15 min. and then it was moved, in a vertical position, to a ring stand. The pressure chamber was then filled slowly with liquid CO_2 to its operating pressure of 820 PSI and temperature of 21°C . The lower part of the loaded pressure chamber was then placed back into the 60°C water bath. Water at 10°C was then allowed to flow to the cold finger condenser at the top of the extractor. All extractions were done for 1 hour after initially determining that the amount of material extracted was the same if the extraction time was 1, 2 or 4, hours. The operating pressure in the chamber was maintained at its initial pressure of 820 PSI during the entire 1 hour extraction period. After the extraction was completed, the chamber was removed from the water bath, the chilled water for the condenser was turned off and the chamber was then de-pressurized, slowly. The de-pressurizing of the chamber usually took 20 minutes. The de-pressurized chamber was then opened quickly and the extracted material was transferred from the flask into a pre-weighed vial with a disposable pipet. The sample vials were stored at -20°C . The thimble containing the extracted charcoal was placed in a desiccator for 1 hour and then weighed to determine the loss of material from the charcoal.

Vacuum Transfer

The original vacuum transfer apparatus shown in Fig. 2 had been modified as shown in Fig. 3. The modifications were made to reduce the potential for vacuum leaks by eliminating greased joints and to eliminate cold spots in the manifold so that the less volatile, relatively higher molecular weight hydrocarbons would be transferred into the receiving flask.

This modification, which eliminated greased joints, prevented the flow of the grease as soon as heat was applied to the system and was, therefore, less likely to leak. The greased joints in the extraction region were replaced with FETFE O-rings. The top of the 250 ml. distilling flask and one end of the manifold were threaded so that a vacuum coupling connector (Ace Glass, Vineland N.J.) could be used instead of a greased joint. The manifold was evacuated from the receiving end of the apparatus instead of the center in order to eliminate a cold spot at the vacuum stopcock manifold connection. The joint at the receiving end of the apparatus was made by using a vacuum adapter with an inner ring design (Ace Glass) to connect to a centrifuge tube. The manifold vacuum gauge was connected directly into the system in order to eliminate another greased connection and to make it possible to monitor the vacuum inside the system during the extraction.

The procedure used to extract the charcoal was the same as had been used for the previous extraction apparatus. Smaller quantities of the charcoal, 5.00g to 20.00g, were extracted instead of the

40.00g used previously in order to conserve the samples.

Gas Chromatographic Equipment and Procedures

All the extracts were analyzed with a Perkin Elmer Model 3920 gas chromatograph equipped with a flame ionization detector. An aliquot of the sample was vaporized into a tedlar bag and then introduced into the GC system with a 10 mL sample loop. This method of sample introduction is the same as had been used in the previous canister study (2,3). A 60 m x 0.32 mm i.d. DB-1 (J & W Scientific) capillary column with a 1.0 μ film thickness was used to separate the C₄ to C₁₃ hydrocarbons. Upon injection of the sample to the capillary column, the sample is cryogenically trapped in the column which was initially cooled to -95°C. After the one-minute injection period, the temperature to the capillary column is ramped to -45°C and then slowly increased at the rate of 8°C/min up to a final temperature of 235°C. The Helium carrier gas flow was maintained at 1.5 mL/min with a Matheson Model 8240 mass flow controller (Matheson Corp., East Rutherford N.J.). The peak area and peak retention time data were recorded and plotted on a Perkin Elmer Sigma 15 chromatographic data station. In addition, the peak area and peak retention time data was stored on cassette tape for later transfer to a computer with a standard RS 232 serial port.

SECTION 5

RESULTS AND DISCUSSION

The CS₂ extraction method extracted up to 8% more material (by weight) from the charcoal than did the modified vacuum transfer procedure, for six of the seven samples tested. In addition, the CS₂ extraction method extracted up to 15% more material (by weight) from the charcoal samples than did the high pressure CO₂ soxhlet extraction procedure (Table 1 and Fig. 4).

Up to 4% more total hydrocarbons on carbon were measured by the GC/FID analysis of the extracts from the CS₂ soxhlet extraction method in comparison to the hydrocarbons measured in the extracts from the vacuum transfer method. In addition, up to 8% more total hydrocarbons on carbon were measured in the CS₂ extracts than were measured in the extracts from the high pressure CO₂ soxhlet extraction procedure (Table 2 and Fig. 5).

In the appendix we present a summary of the hydrocarbons measured in the extracts, for all the samples analyzed, by the three methods used to extract the charcoal. This summary resulted from the sorting of the individual hydrocarbon measurement data in a Lotus^R format. The data transferred from cassette tape to the computer was manipulated using a peak identification and peak-editing program developed in this laboratory (4). The individual hydrocarbon data has been stored on the computer and is available by request to the author.

The results just described, and presented in the appendix, are the same as had been reported in a previous canister study

(Report to Cliff Dean, MOD, July 15, 1986). More material (by weight) was extracted from the charcoal and the total hydrocarbons on carbon measured in the extracts were greater with the CS₂ soxhlet extraction method than by either the previous or modified vacuum transfer methods or the high pressure CO₂ soxhlet extraction method. The total hydrocarbons on carbon measured in the CS₂ extracts were greater than the total hydrocarbons measured in the extracts by the other extraction methods because CS₂ extracts more of the relatively higher molecular weight, less volatile, alkyl aromatics than the other methods. In our previous canister studies we had determined that used "aged" canisters contained significant quantities of these alkyl aromatics.

More of the relatively lower molecular weight, more volatile hydrocarbons were measured in the extracts from the vacuum transfer method than by either the CS₂ soxhlet method or by the high pressure CO₂ method. This result is as expected, since the most volatile material is lost through the condenser of the CS₂ extraction method and also the CS₂ solvent peak interferes with the measurement of the C₅ hydrocarbons. The loss of the more volatile hydrocarbons with the high pressure soxhlet extraction method was due to: 1) volatile compounds were lost when a slight vacuum was pulled on the heated pressure chamber before filling it with liquid CO₂ and, 2) volatile compounds were lost when the pressure chamber was de-pressurized over the 20 minute time period because the extract was being warmed from liquid CO₂ temperatures to ambient. The results show that considerable losses of the volatile compounds

occurred when the two charcoal samples that were taken from an in-house evaporative emissions project (Gasoline Base and Blend) were extracted by the high pressure CO₂ method. These charcoal samples contained a significant quantity of the more volatile hydrocarbons and it was difficult to retain the hydrocarbons in this soxhlet extraction system.

Three separate samples of sample A151/0282 were extracted for 1, 2 and 4 hours with the high pressure CO₂ soxhlet extraction method to determine the most favorable extraction time. The results (Table 3 and Figs. 6 and 6A) of these extractions showed that 1 hour was sufficient time to do the extraction, as the amount of material extracted varied by less than 5% between the samples. In addition, the quantity of hydrocarbons measured in the extracts varied by less than 15% with more hydrocarbons being measured in the 1 hour extract.

Modification of the vacuum transfer apparatus did not result in either increasing the quantity of material extracted from the charcoal or in increasing the quantity of hydrocarbons that could be measured in the extract as compared to the previous vacuum transfer method (Tables 4 and 5 and Figs. 7 and 7A and 8 and 8A). More of the higher molecular weight, relatively less volatile hydrocarbons, were measured in the extracts with the modified apparatus than with the previous method for the two samples that could be compared. This increase in less volatile material could be attributable to the elimination of cold spots in the apparatus. The loss of the more volatile hydrocarbons from this extraction

apparatus may have been caused by leaks around the heated o-rings, since relatively high temperatures (400°C) are used to do these extractions. Two separate samples of sample Gasoline (Base) were extracted using the modified vacuum transfer method and the results are presented in Table 6 and 7 and Figs. 9 and 9A). The variability in the amount of material extracted and in the quantity of hydrocarbons measured was less than 5%, which shows that this method is reproducible but not accurate for samples containing high concentrations of compounds of low volatility.

References

1. W. G. Jennings, "Vapor-Phase Sampling." Journal of High Resolution Chromatography and Chromatography Communications Vol 2, (221-224) May 1979.
2. D. Dropkin Final Report to C. Dean (MOD) July 15, 1986.
3. R Zweidinger Report to T. Tesoriero (MOD) Dec. 14, 1984.
4. S.B. Tejada and J. Sigsby Jr., "Identification of Chromatographic Peaks Using Lotus 1-2-3^R." J. Chromatogr. Sci. 26,494-500 (1988).

ALL METAL PARTS
304 STAINLESS STEEL

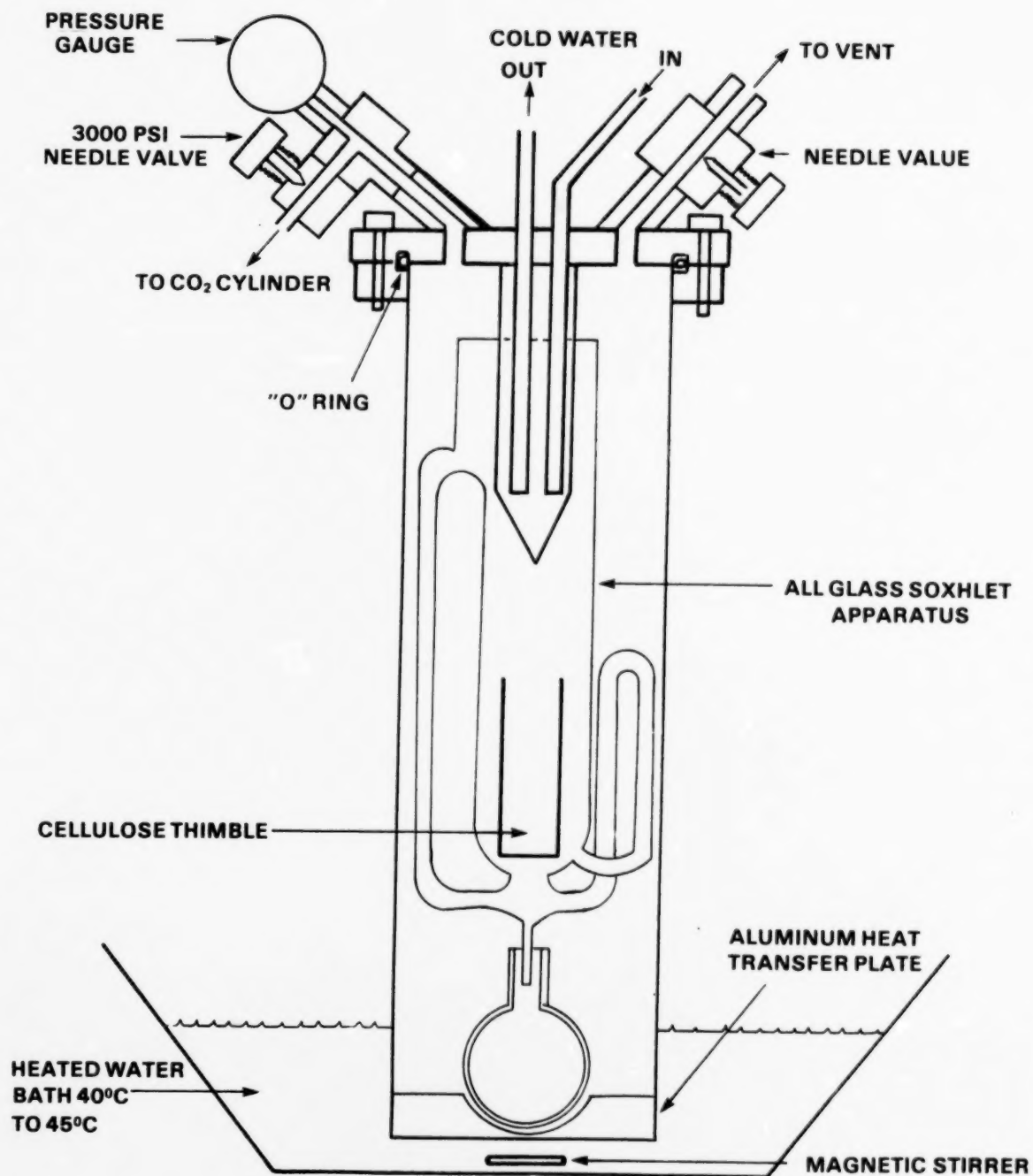


Figure 1. High pressure CO₂ soxhlet extractor.

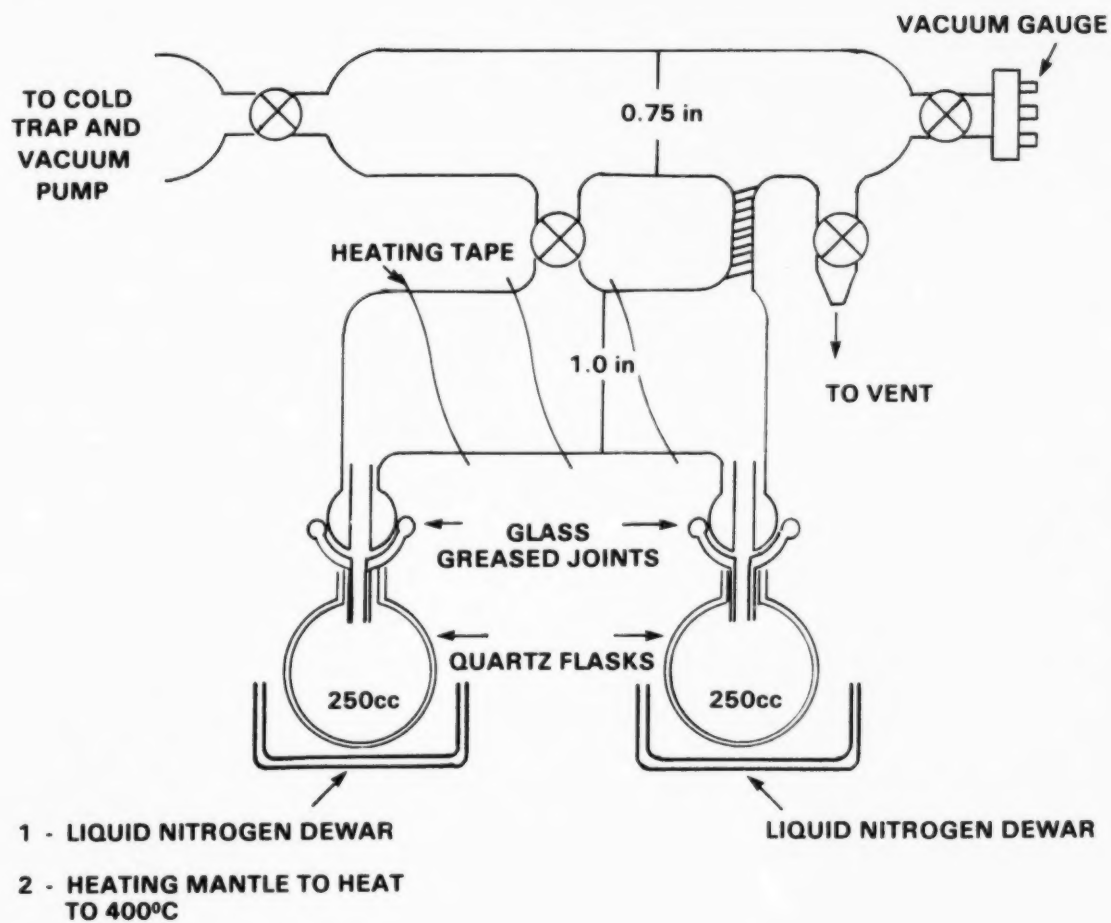


Figure 2. Previous vacuum transfer apparatus.

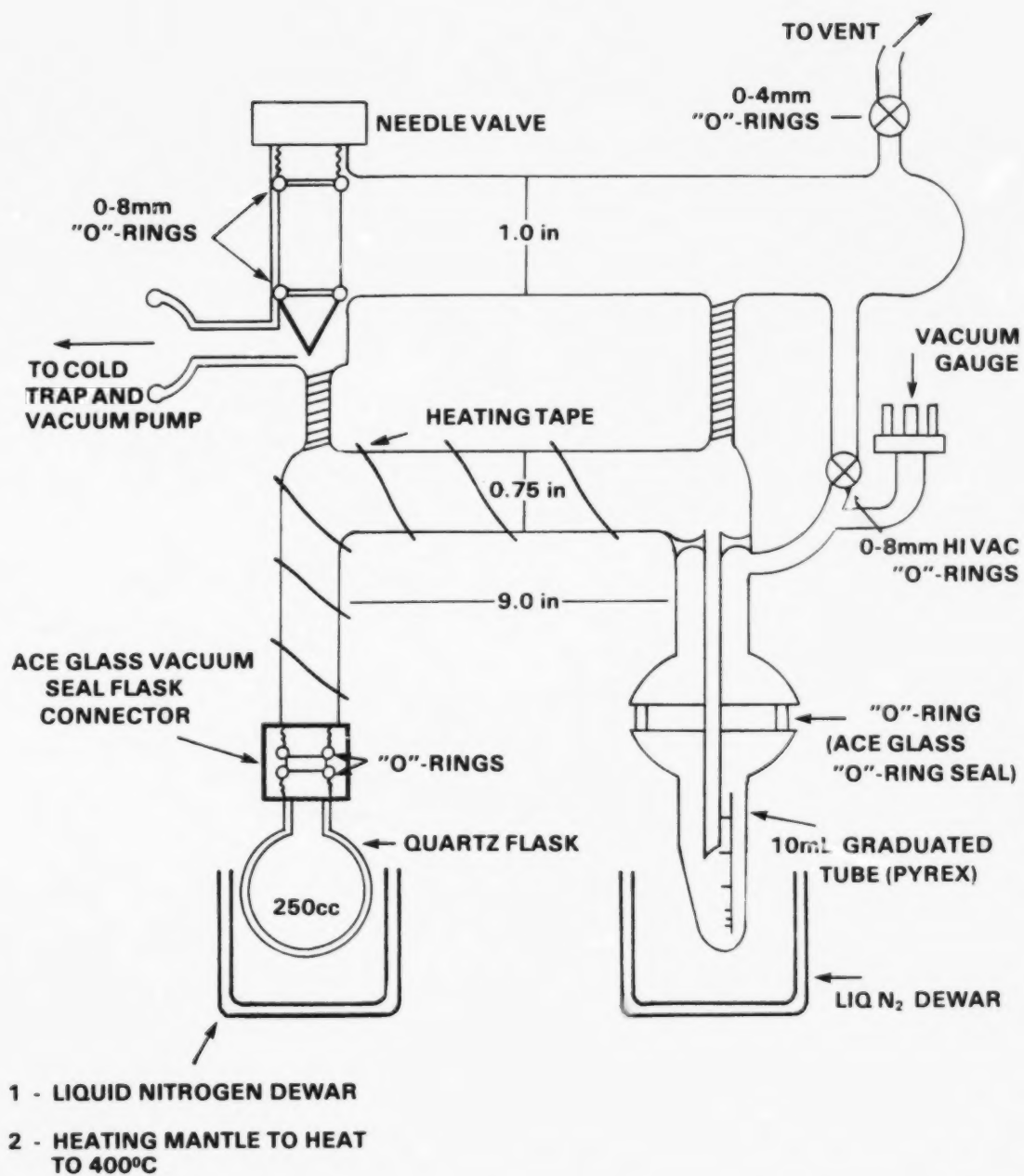


Figure 3. Present vacuum transfer apparatus.

Table 1
COMPARISON OF CHARCOAL EXTRACTION METHODS
PERCENT (BY WEIGHT) MATERIAL EXTRACTED FROM CHARCOAL

SAMPLE NUMBER =====	METHODS		
	CS2 SOXHLET EXTRACTION =====	MODIFIED VACUUM TRANSFER =====	HIGH PRESSURE CO2 SOXHLET EXTRACTION =====
A152/0237	31.10	23.30	16.60
A151/0420	44.59	47.36	36.80
A151/0320X	36.60	33.98	24.00
A151/0282	35.20	30.40	28.20
A152/0599	25.60	19.40	17.80
GASOLINE-BASE	22.40	21.40	14.30
GASOLINE-BLEND	20.85	18.20	19.70

COMPARISON OF CHARCOAL EXTRACTION METHODS

Percent (by weight) material extracted
from the charcoal

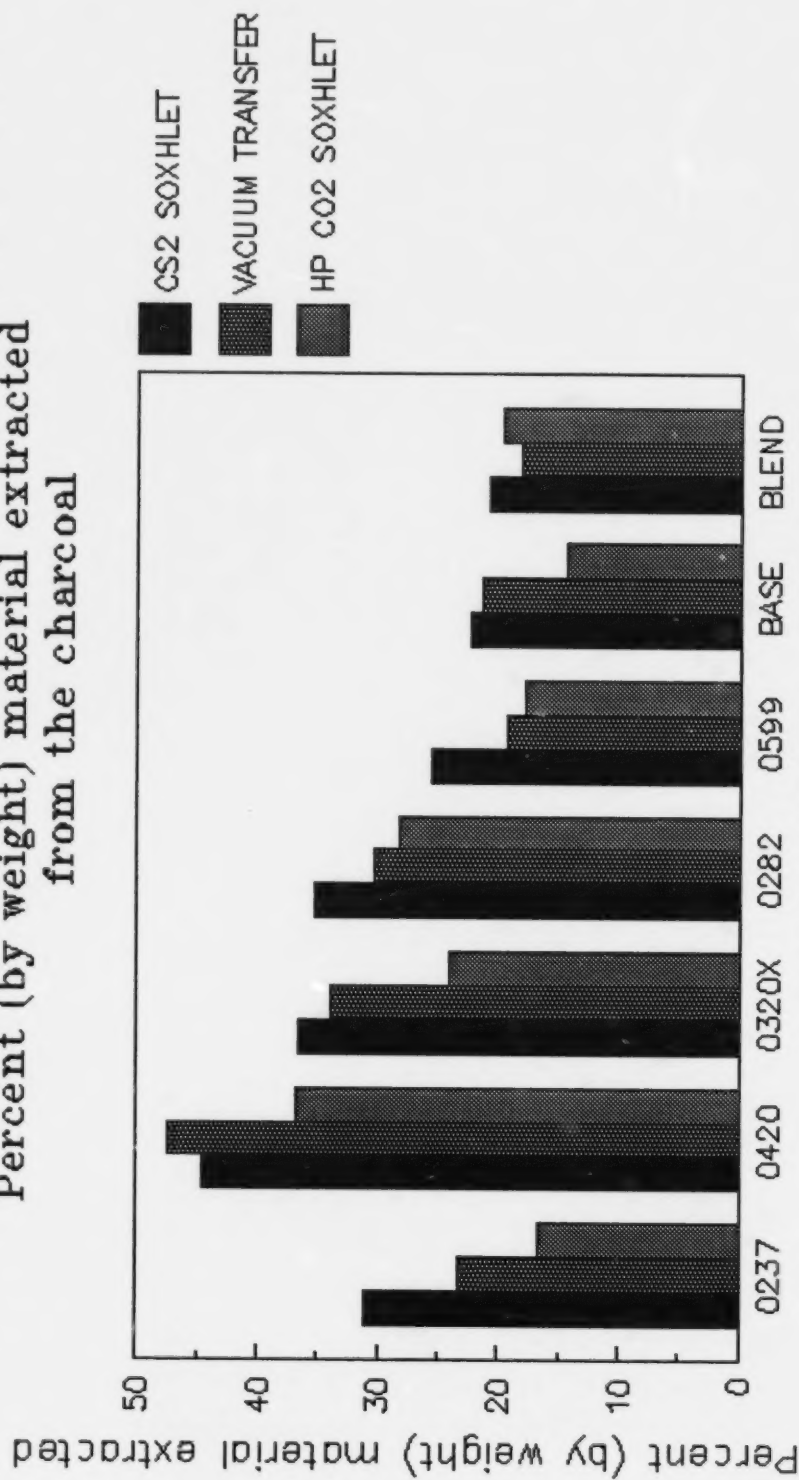


Figure 4

Table 2
COMPARISON OF CHARCOAL EXTRACTION METHODS
PERCENT (BY WEIGHT) HYDROCARBON ON CARBON
FROM GC/FID

SAMPLE NUMBER =====	METHODS		
	CS2 SOXHLET EXTRACTION =====	MODIFIED VACUUM TRANSFER =====	HIGH PRESSURE CO2 SOXHLET EXTRACTION =====
A152/0237	21.54	17.34	14.54
A151/0420	33.13	32.13	25.53
A151/0320X	14.96	13.43	10.97
A151/0282	22.87	21.15	18.19
A152/0599	15.39	15.63	10.31
GASOLINE-BASE	15.01	13.82	NM(1)
GASOLINE-BLEND	11.90	10.90	6.69

1 - NM = NOT MEASURED

COMPARISON OF CHARCOAL EXTRACTION METHODS PERCENT (BY WEIGHT) HYDROCARBON ON CARBON FROM GC/FID

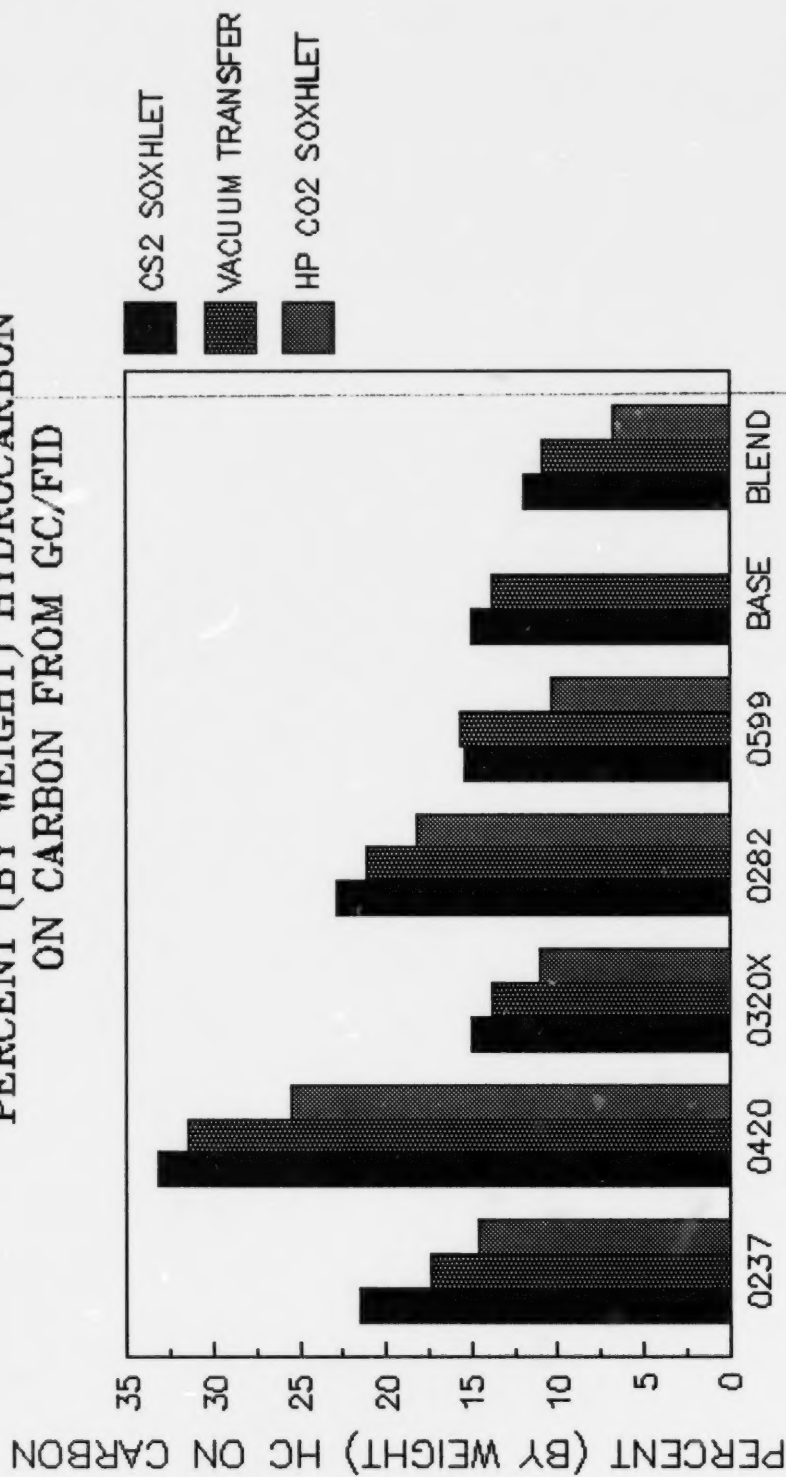


Figure 5

Table 3

PERCENT (BY WEIGHT) HYDROCARBON ON CARBON
AFTER EXTRACTING FOR 1,2 AND 4 HOURS USING
HIGH PRESSURE CO2 SOXHLET EXTRACTION

SAMPLE NUMBER A151/0282
DATE REMOVED 3-24-86

CLASS =====	HIGH PRESSURE CO2 SOXHLET EXTRACTION 1 HR. =====	HIGH PRESSURE CO2 SOXHLET EXTRACTION 2 HR. =====	HIGH PRESSURE CO2 SOXHLET EXTRACTION 4 HR. =====
TOTAL N-PARAFFINS	0.37	0.57	0.57
TOTAL BRANCHED PARAFFINS	2.74	3.50	3.72
TOTAL NAPHTHANES	0.03	0.07	0.05
TOTAL OLEFINS	0.26	0.09	0.13
TOTAL AROMATICS	12.50	9.33	10.81
TOTAL UNKNOWNNS	2.29	2.06	2.55
TOTAL %HC ON CARBON FROM GC/FID	18.19	15.63	17.83
METHOD % EXTRACTED	27.70	28.30	28.20

PERCENT (BY WEIGHT) HYDROCARBON ON CARBON AFTER EXTRACTING FOR 1,2 AND 4 HOURS USING HIGH PRESSURE CO2 EXTRACTION

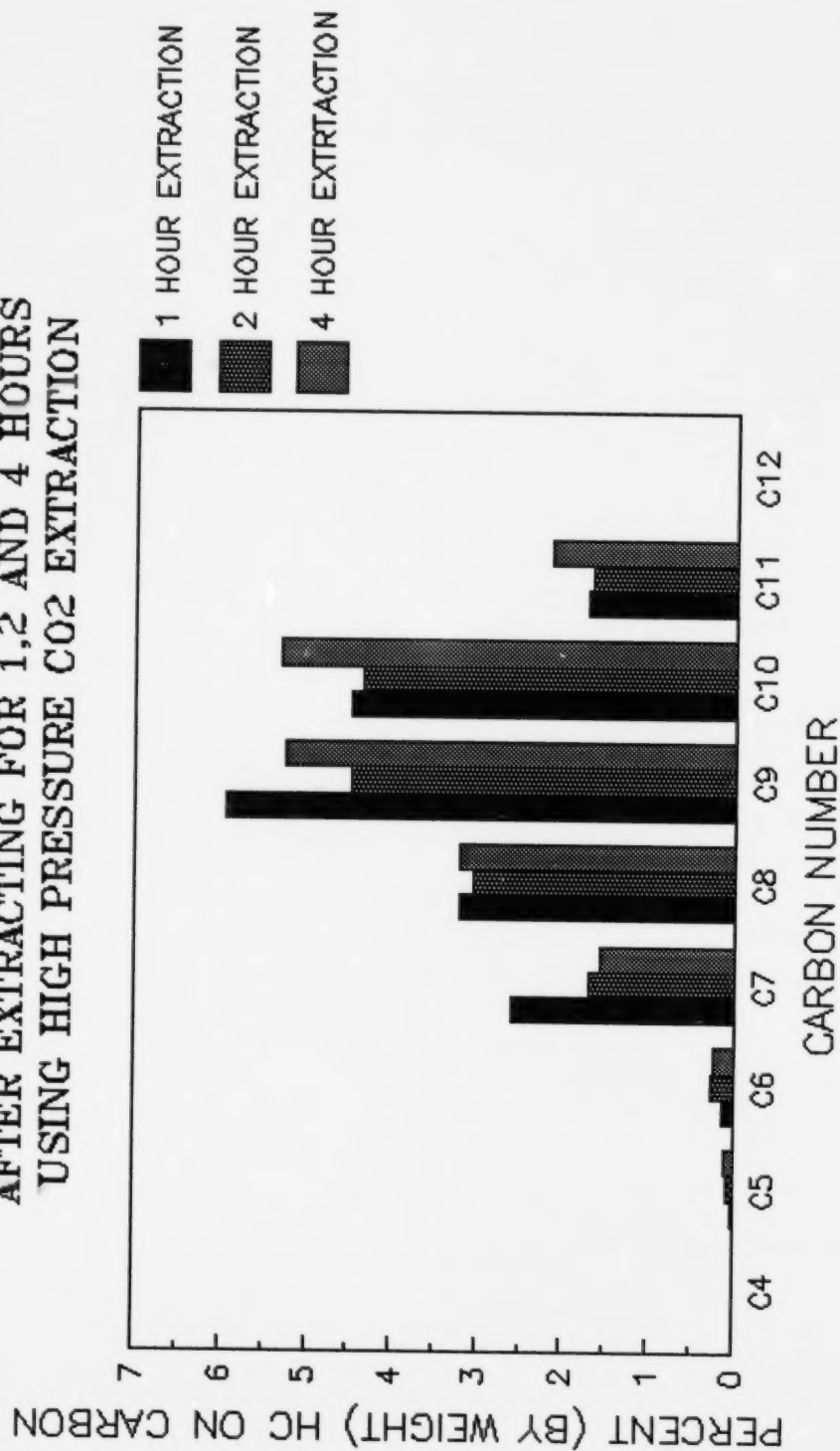
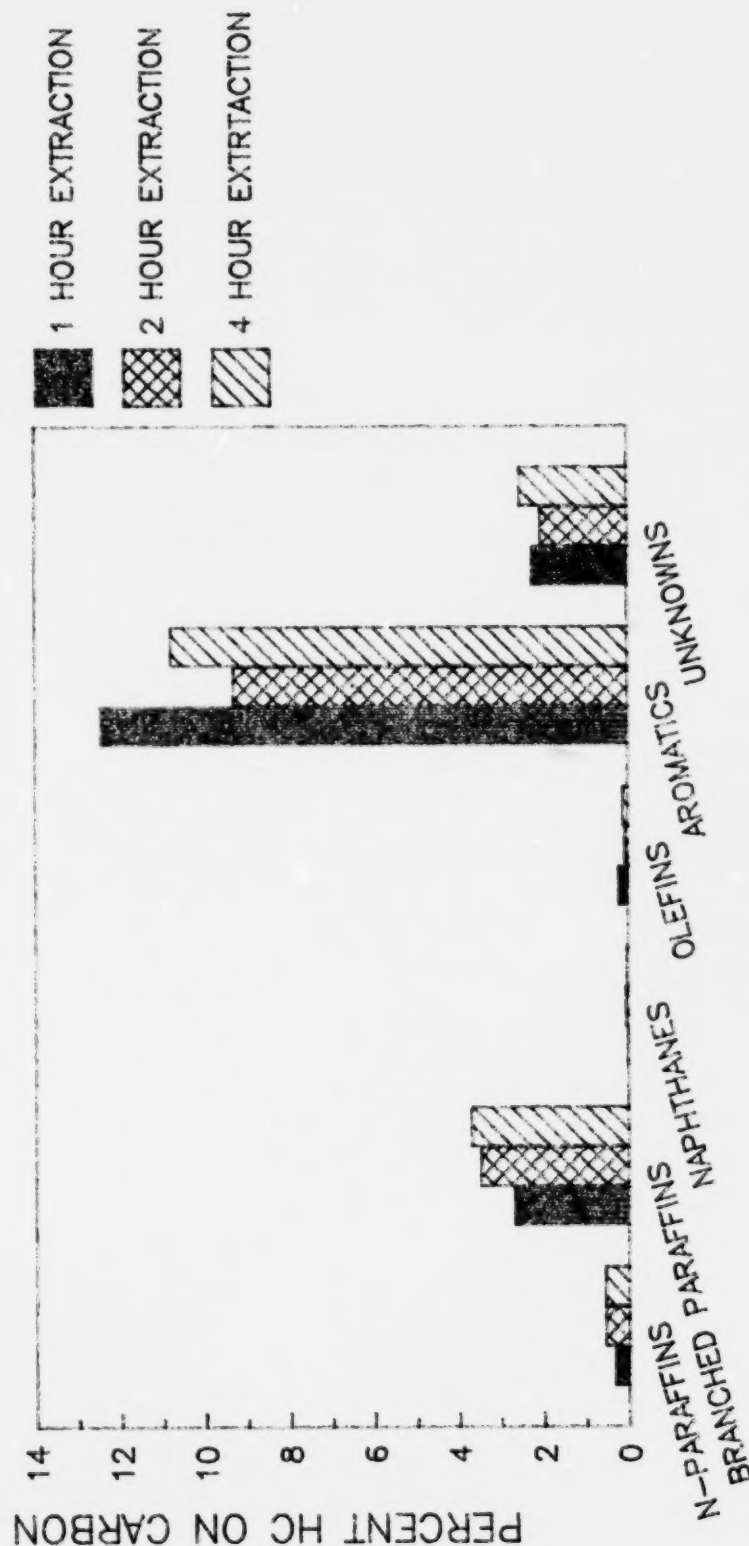


Figure 6

SAMPLE NUMBER A151/0282
DATE REMOVED 3-24-86

PERCENT (BY WEIGHT) HYDROCARBON ON CARBON AFTER EXTRACTING FOR 1,2 AND 4 HOURS USING HIGH PRESSURE CO2 SOXHLET METHOD



COMPOUND CLASS

Figure 6A

SAMPLE NUMBER A151/0282
 DATE REMOVED 3-24-86

TABLE 4
COMPARISON OF PREVIOUS AND MODIFIED
VACUUM TRANSFER METHODS

PERCENT (BY WEIGHT) HYDROCARBON ON CARBON

SAMPLE NUMBER A152/0237

DATE REMOVED 8-22-84

CLASS =====	PREVIOUS VACUUM TRANSFER =====	MODIFIED VACUUM TRANSFER =====
TOTAL N-PARAFFINS	1.20	0.82
TOTAL BRANCHED PARAFFINS	5.63	4.97
TOTAL NAPHTHANES	0.33	0.18
TOTAL OLEFINS	0.29	0.43
TOTAL AROMATICS	12.50	9.65
TOTAL UNKNOWNNS	0.28	1.30
TOTAL % HC ON CARBON FROM GC/FID	20.19	17.35
METHOD % EXTRACTED	25.98	23.30
% MOIS.	2.50	2.60
% OF EXTRACT REPORTED BY GC/FID	87.34	85.58

COMPARISON OF PREVIOUS AND MODIFIED

VACUUM TRANSFER METHODS

Percent (by weight) hydrocarbon on carbon

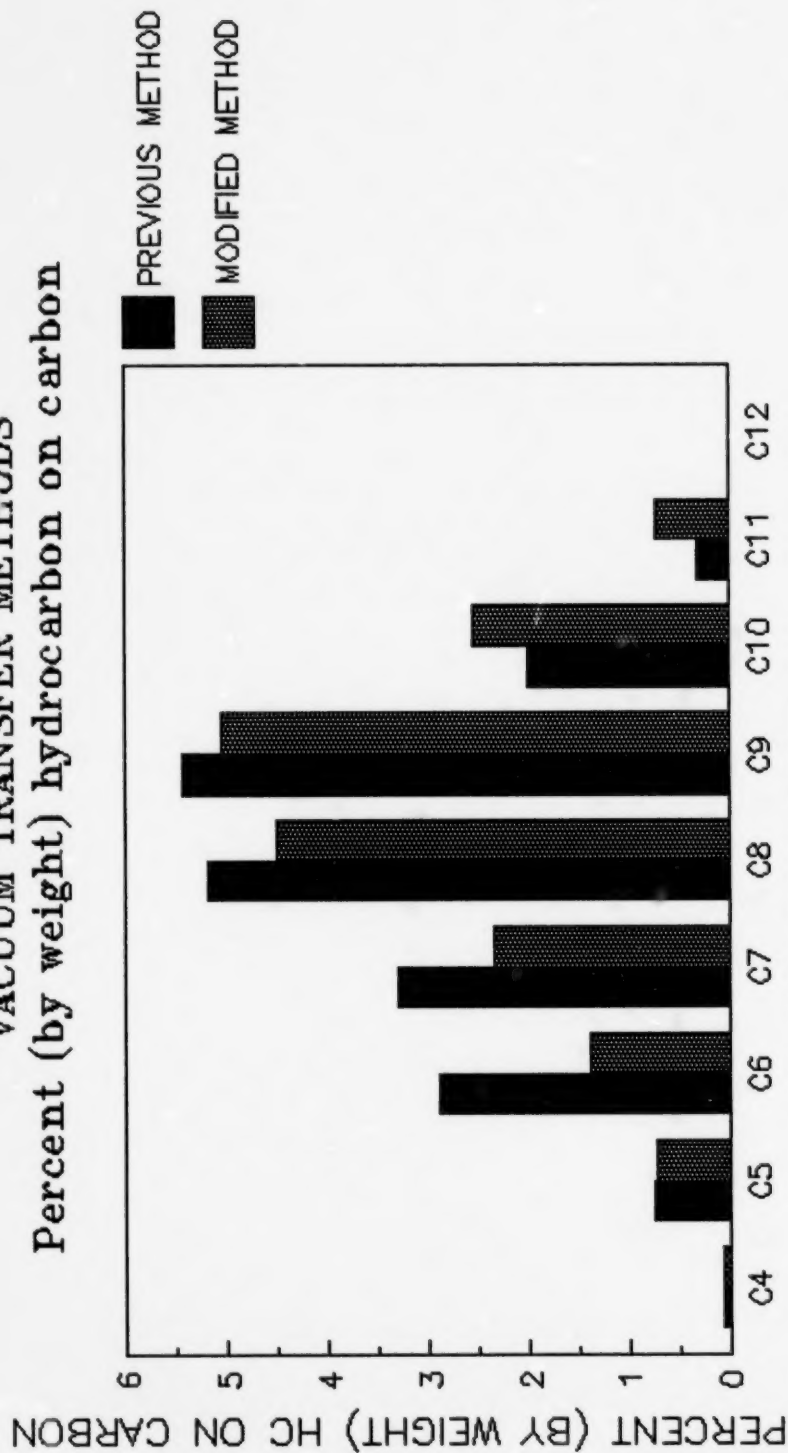


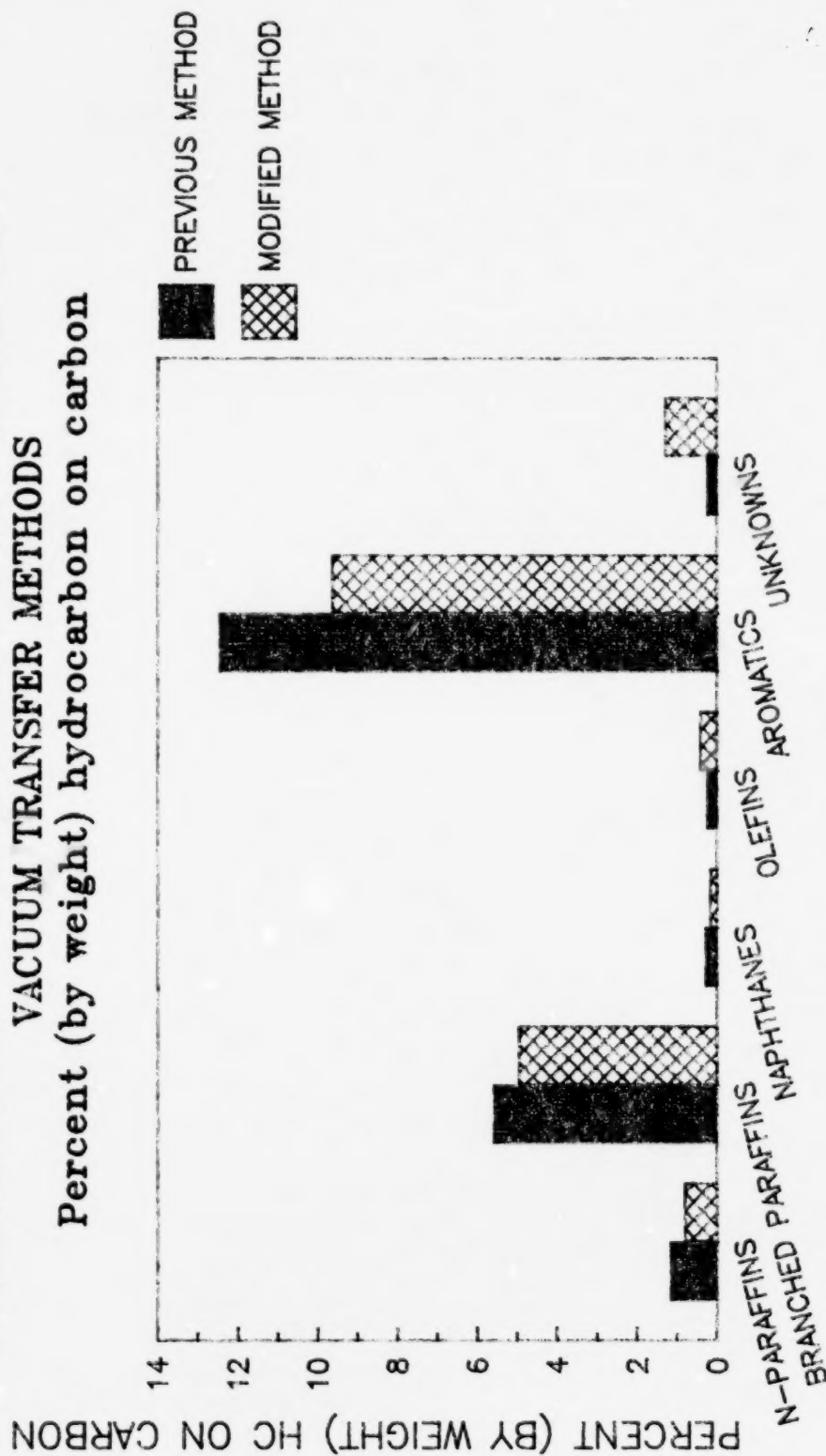
Figure 7

SAMPLE NUMBER A151/0237
DATE REMOVED 8-22-84

COMPARISON OF PREVIOUS AND MODIFIED

VACUUM TRANSFER METHODS

Percent (by weight) hydrocarbon on carbon



COMPOUND CLASS

Figure 7A

SAMPLE NUMBER A151/0237
DATE REMOVED 8-22-84

TABLE 5

COMPARISON OF PREVIOUS AND MODIFIED

VACUUM TRANSFER METHODS

PERCENT (BY WEIGHT) HYDROCARBON ON CARBON

SAMPLE NUMBER A152/0599

DATE REMOVED 6-3-85

CLASS =====	PREVIOUS VACUUM TRANSFER =====	MODIFIED VACUUM TRANSFER =====
TOTAL N-PARAFFINS	1.41	1.10
TOTAL BRANCHED PARAFFINS	7.11	7.80
TOTAL NAPHTHANES	0.28	0.10
TOTAL OLEFINS	0.13	0.22
TOTAL AROMATICS	5.84	5.71
TOTAL UNKNOWNNS	0.04	0.69
TOTAL % HC ON CARBON FROM GC/FID	14.81	15.63
METHOD % EXTRACTED	17.10	19.40
% MOIS.	1.10	0.10
% OF EXTRACT REPORTED BY GC/FID	93.04	80.57

COMPARISON OF PREVIOUS AND MODIFIED

VACUUM TRANSFER METHODS

Percent (by weight) hydrocarbon on carbon

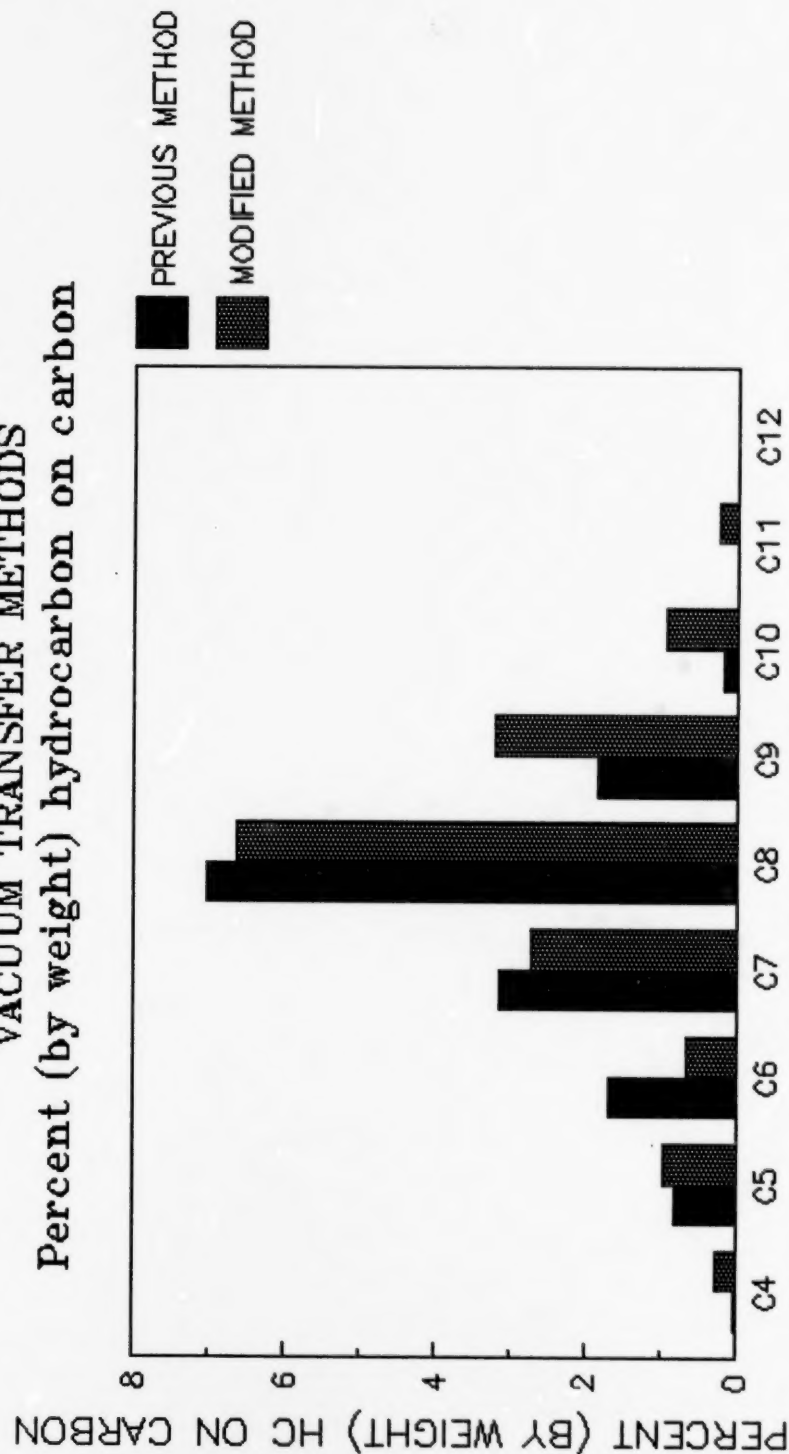
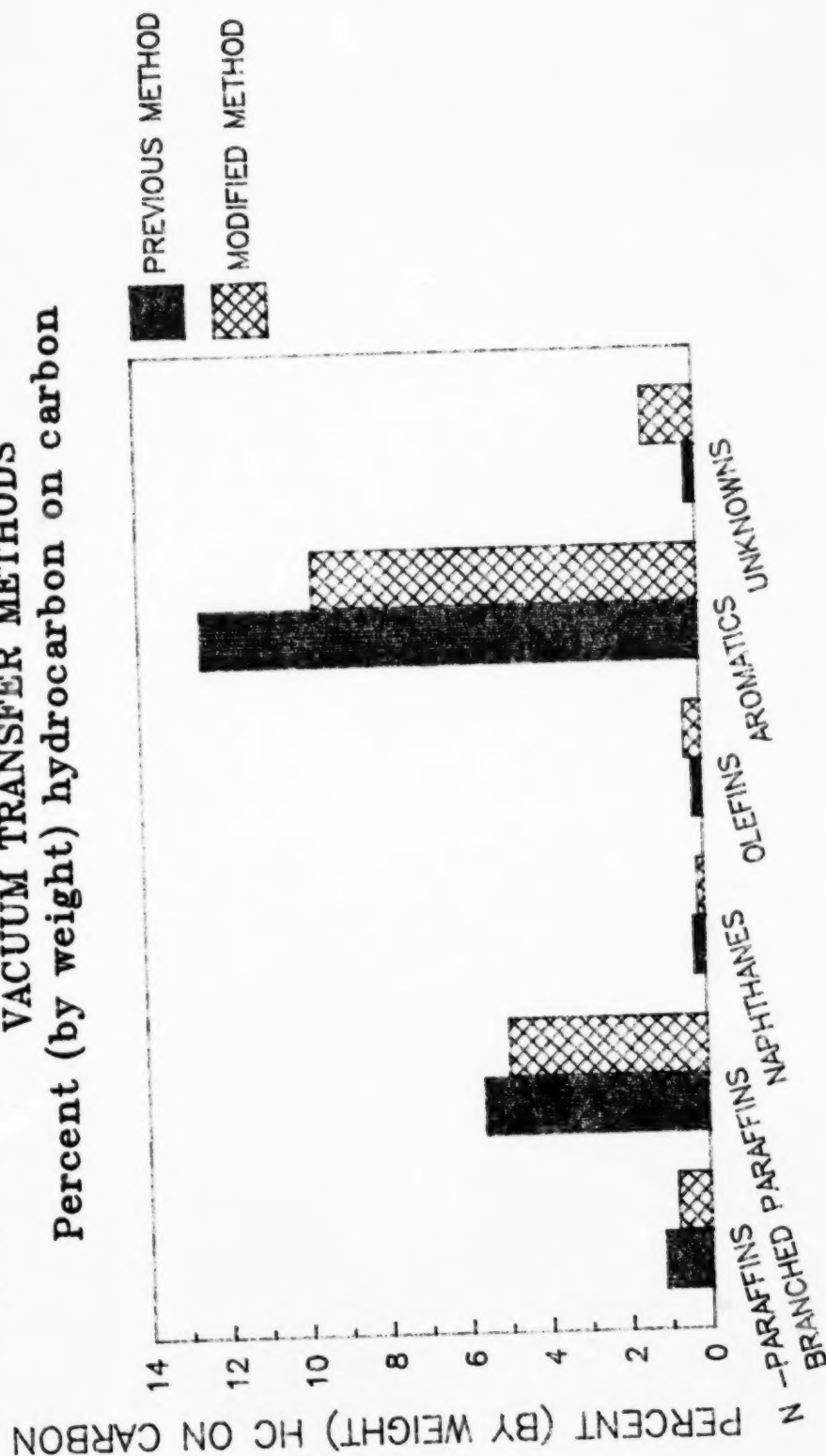


Figure 8

SAMPLE NUMBER A152/0599
DATE REMOVED 6-3-85

COMPARISON OF PREVIOUS AND MODIFIED VACUUM TRANSFER METHODS

Percent (by weight) hydrocarbon on carbon



COMPOUND CLASS

Figure 8A

SAMPLE NUMBER A152/0599
DATE REMOVED 6-3-85

TABLE 6

RESULTS OF THE ANALYSIS OF SAMPLE GASOLINE (BASE)
ANALYZED IN DUPLICATE USING THE MODIFIED
VACUUM TRANSFER METHOD

PERCENT (BY WEIGHT) HYDROCARBON ON CARBON

SAMPLE NUMBER GASOLINE (BASE)

DATE REMOVED	NA	(1) MODIFIED VACUUM TRANSFER =====	(2) MODIFIED VACUUM TRANSFER =====
CLASS			
=====			
TOTAL N-PARAFFINS		1.02	1.06
TOTAL BRANCHED PARAFFINS		7.39	7.46
TOTAL NAPHTHANES		0.38	0.40
TOTAL OLEFINS		1.48	1.57
TOTAL AROMATICS		3.11	2.88
TOTAL UNKNOWNNS		0.44	0.37
TOTAL % HC ON CARBON FROM GC/FID		13.82	13.74
METHOD % EXTRACTED		21.30	21.40

RESULTS OF THE ANALYSIS OF SAMPLE GASOLINE (BASE) ANALYZED IN DUPLICATE USING THE MODIFIED VACUUM TRANSFER METHOD

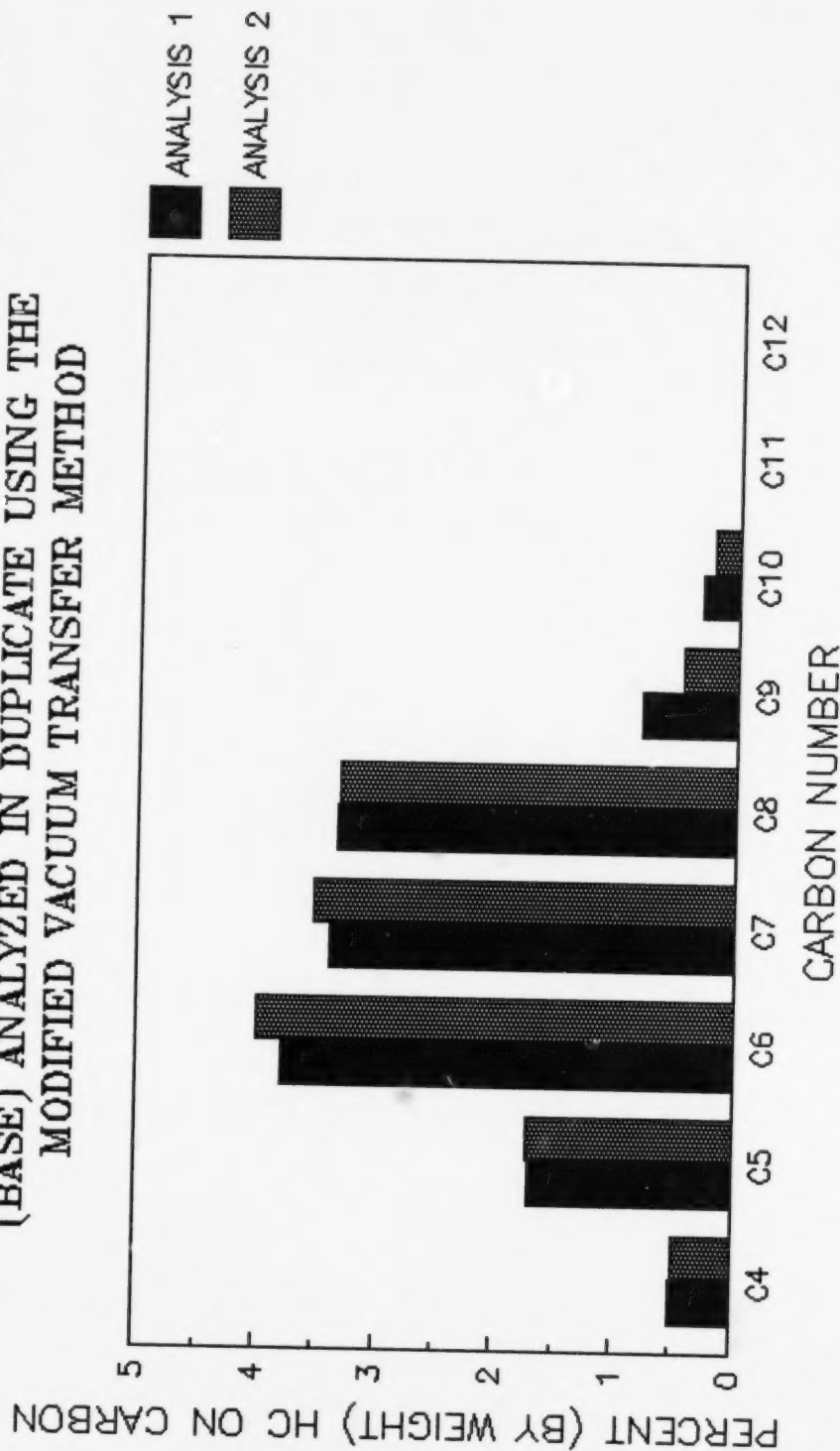


Figure 9

SAMPLE NUMBER GASOLINE (BASE)
DATE REMOVED NA

APPENDIX A

- 1 Sample A151/0237
- 2 Sample A151/0420
- 3 Sample A151/0320X
- 4 Sample A151/0282
- 5 Sample A152/0599
- 6 Sample Gasoline (Base)
- 7 Sample Gasoline (Blend)

COMPARISON OF CHARCOAL EXTRACTION METHODS

SAMPLE NUMBER A152/0237

DATE REMOVED 8-22-84

METHODS

CLASS =====	CS2 SOXHLET EXTRACTION =====	MODIFIED VACUUM TRANSFER =====	HIGH PRESSURE CO2 SOXHLET EXTRACTION =====
TOTAL N-PARAFFINS	0.96	0.87	0.53
TOTAL BRANCHED PARAFFINS	5.94	5.31	3.22
TOTAL NAPHTHANES	0.23	0.16	0.07
TOTAL OLEFINS	0.17	0.48	0.05
TOTAL AROMATICS	12.55	9.19	9.06
TOTAL UNKNOWNNS	1.70	1.34	2.32
TOTAL % HC ON CARBON FROM GC/FID	21.54	17.34	14.54
METHOD % EXTRACTED	31.10	23.30	16.60
% MOIS.	1.80	2.60	1.80
% OF EXTRACT REPORTED BY GC/FID	74.93	85.58	98.43

COMPARISON OF COAL EXTRACTION METHODS

PERCENT (BY WEIGHT) HYDROCARBON ON CARBON
BY CARBON NUMBER AND COMPOUND CLASSSAMPLE NUMBER A151/0237
DATE REMOVED 8-22-84

CS2 SOXHLET EXTRACTION (3 HOUR EXTRACTION)

HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL N-PARAFFINS			0.24	0.06	0.17	0.19	0.16	0.09	0.04	0.95
TOTAL BRANCHED PARAFFINS			0.66	0.44	2.65	0.66	0.79	0.43		5.19
TOTAL NAPHTHANES			0.13	0.03	0.03	0.04				0.23
TOTAL OLEFINS			0.10	0.02	0.04	0.01				0.17
TOTAL AROMATICS			0.20	1.74	1.92	5.20	3.06	1.17		13.29
TOTAL UNKNOWNNS			0.01		0.02	0.05	0.51	0.55	0.57	1.70
TOTAL WT. %			1.34	2.29	4.83	6.15	4.52	1.81	0.61	21.54
% OF TOTAL			6.21	10.61	22.42	28.55	21.00	8.40	2.82	

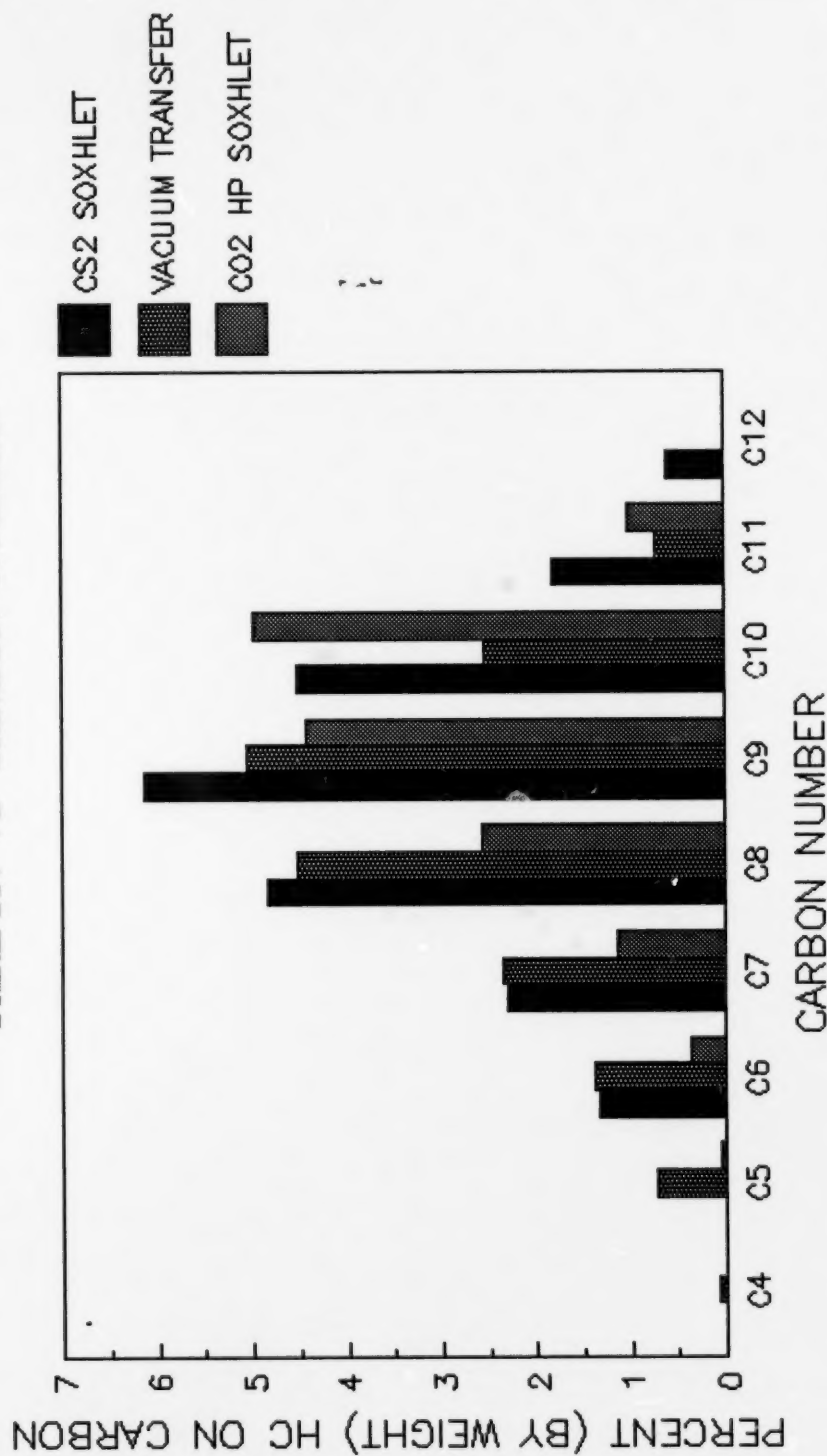
MODIFIED VACUUM TRANSFER (4 HOUR EXTRACTION)

HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL N-PARAFFINS	0.02	0.24	0.21	0.09	0.02		0.12	0.12		0.82
TOTAL BRANCHED PARAFFINS	0.01	0.35	0.54	0.46	2.42	0.62	0.39	0.18		4.97
TOTAL NAPHTHANES		0.03	0.12	0.02	0.02					0.18
TOTAL OLEFINS	0.03	0.07	0.13	0.02	0.18					0.43
TOTAL AROMATICS			0.24	1.72	1.82	3.93	1.90	0.04		9.65
TOTAL UNKNOWNNS	0.01	0.03	0.15	0.02	0.06	0.51	0.14	0.39		1.30
TOTAL WT. %	0.07	0.73	1.38	2.34	4.51	5.05	2.55	0.72		17.35
% OF TOTAL	0.38	4.19	7.96	13.48	26.00	29.13	14.73	4.15		

HIGH PRESSURE CO2 SOXHLET EXTRACTION (1 HOUR EXTRACTION)

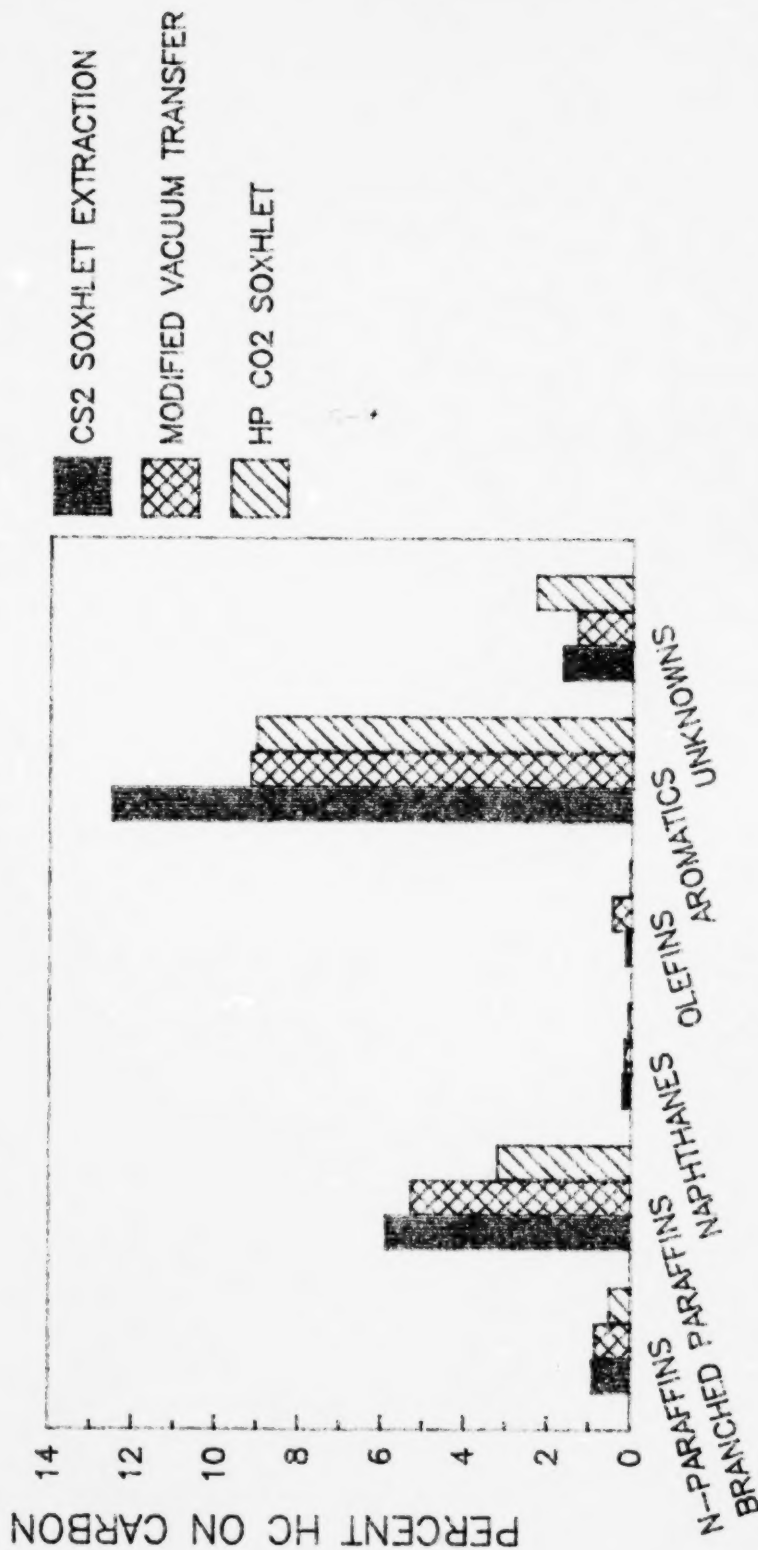
HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL N-PARAFFINS	0.00	0.02	0.06	0.05	0.01		0.15	0.20		0.49
TOTAL BRANCHED PARAFFINS	0.00	0.02	0.13	0.20	1.24	0.45	0.97	0.22		3.22
TOTAL NAPHTHANES		0.00	0.04	0.02	0.01					0.08
TOTAL OLEFINS		0.01	0.04	0.01	0.10					0.16
TOTAL AROMATICS			0.08	0.86	1.15	3.56	3.19	0.22		9.06
TOTAL UNKNOWNNS			0.03	0.00	0.06	0.41	0.66	0.37		1.54
TOTAL WT. %	0.00	0.05	0.37	1.14	2.57	4.42	4.99	1.02		14.54
% OF TOTAL	0.03	0.38	2.57	7.83	17.65	30.39	34.30	7.01		

COMPARISON OF CHARCOAL EXTRACTION METHODS PERCENT (BY WEIGHT) HYDROCARBON ON CARBON VS CARBON NUMBER



SAMPLE NUMBER A151/0237
DATE REMOVED 8-22-84

COMPARISON OF CHARCOAL EXTRACTION METHODS PERCENT (BY WEIGHT) HYDROCARBON ON CARBON



SAMPLE NUMBER A152/0237
DATE REMOVED 8-22-84

COMPARISON OF CHARCOAL EXTRACTION METHODS

SAMPLE NUMBER A151/0420

DATE REMOVED 4-3-86

METHODS

CLASS =====	CS2 SOXHLET EXTRACTION =====	MODIFIED VACUUM TRANSFER =====	HIGH PRESSURE CO2 SOXHLET EXTRACTION =====
TOTAL N-PARAFFINS	0.89	1.35	1.08
TOTAL BRANCHED PARAFFINS	2.52	2.83	1.65
TOTAL NAPHTHANES	0.13	0.11	0.03
TOTAL OLEFINS	0.04	0.43	0.04
TOTAL AROMATICS	21.23	21.60	18.52
TOTAL UNKNOWNNS	8.31	5.80	4.21
TOTAL % HC ON CARBON FROM GC/FID	33.13	32.13	25.53
METHOD % EXTRACTED	44.59	47.36	36.80
% MOIS.	4.80	8.20	4.80
% OF EXTRACT REPORTED BY GC/FID	85.21	85.16	82.42

COMPARISON OF CHARCOAL EXTRACTION METHODS

PERCENT (BY WEIGHT) HYDROCARBON ON CARBON
BY CARBON NUMBER AND COMPOUND CLASSSAMPLE NUMBER A151/0420
DATE REMOVED 4-3-86

CS2 SOXHLET EXTRACTION (3 HOUR EXTRACTION)

HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS			0.03	0.04	0.03	0.07	0.21	0.32	0.19	0.89
TOTAL BRANCHED PARAFFINS			0.02	0.12	0.30	0.10	0.45	1.53		2.52
TOTAL NAPHTHANES			0.09	0.05		0.00				0.13
TOTAL OLEFINS			0.01	0.03	0.00					0.04
TOTAL AROMATICS			0.26	0.54	2.09	8.19	8.54	1.62		21.23
TOTAL UNKNOWNNS			0.01	0.03	0.02	0.03	2.07	2.04	4.12	8.31
TOTAL WT. %			0.42	0.80	2.44	8.38	11.26	5.51	4.31	33.13
% OF TOTAL			1.28	2.42	7.37	25.30	33.99	16.62	13.01	

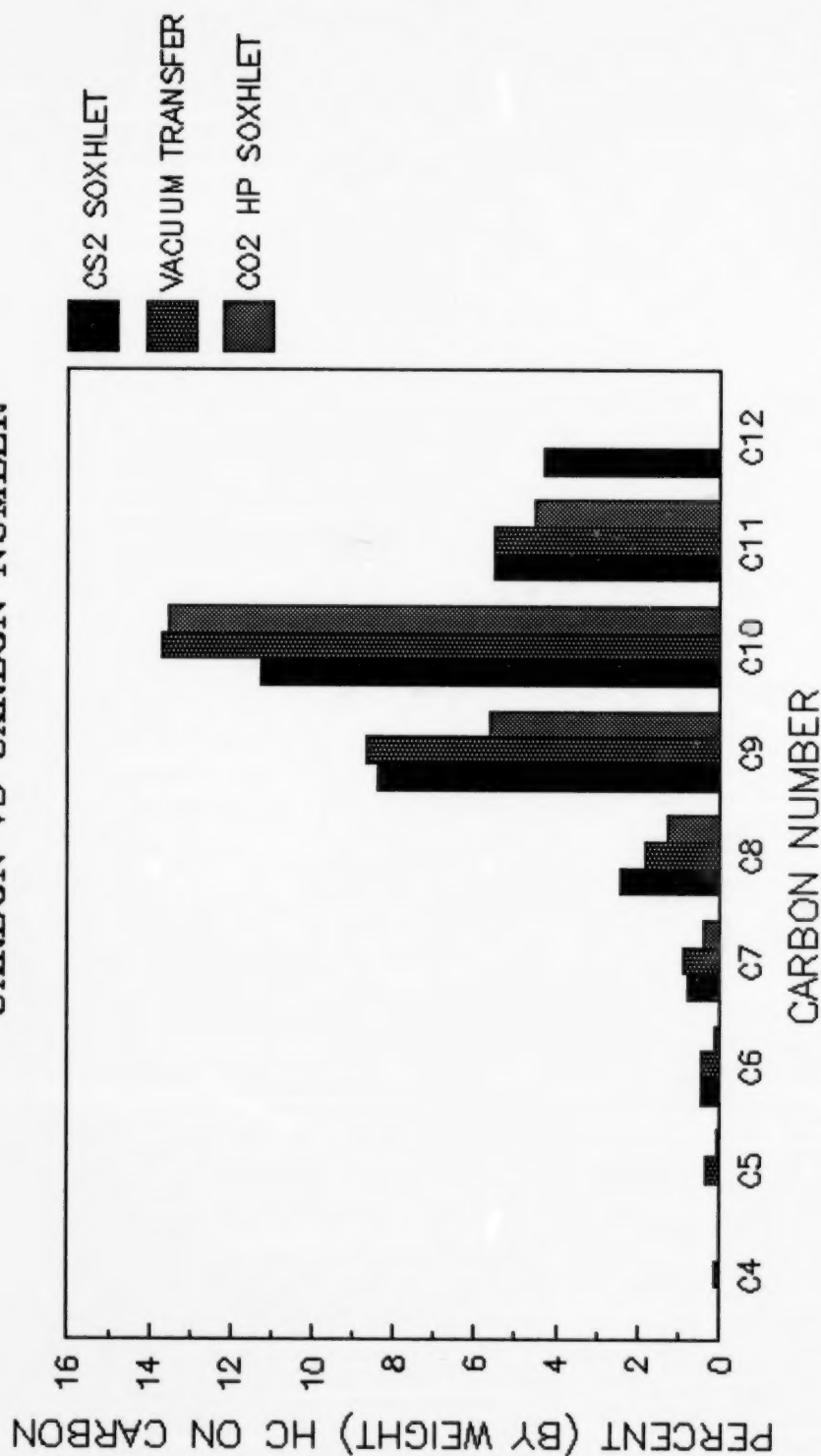
MODIFIED VACUUM TRANSFER (4 HOUR EXTRACTION)

HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.01	0.01	0.05	0.05	0.06		0.21	0.90		1.29
TOTAL BRANCHED PARAFFINS	0.01	0.10	0.12	0.23	0.41	0.18	1.91	0.64		3.59
TOTAL NAPHTHANES		0.00	0.06	0.05	0.01					0.13
TOTAL OLEFINS	0.10	0.19	0.08	0.08	0.05					0.50
TOTAL AROMATICS			0.11	0.46	1.16	8.18	10.26	0.94		21.11
TOTAL UNKNOWNNS		0.03	0.03	0.01	0.16	0.32	1.30	3.04		4.88
TOTAL WT. %	0.12	0.32	0.45	0.87	1.84	8.68	13.68	5.51		31.49
% OF TOTAL	0.39	1.01	1.44	2.77	5.86	27.56	43.46	17.50		

HIGH PRESSURE CO2 SOXHLET EXTRACTION (1 HOUR EXTRACTION)

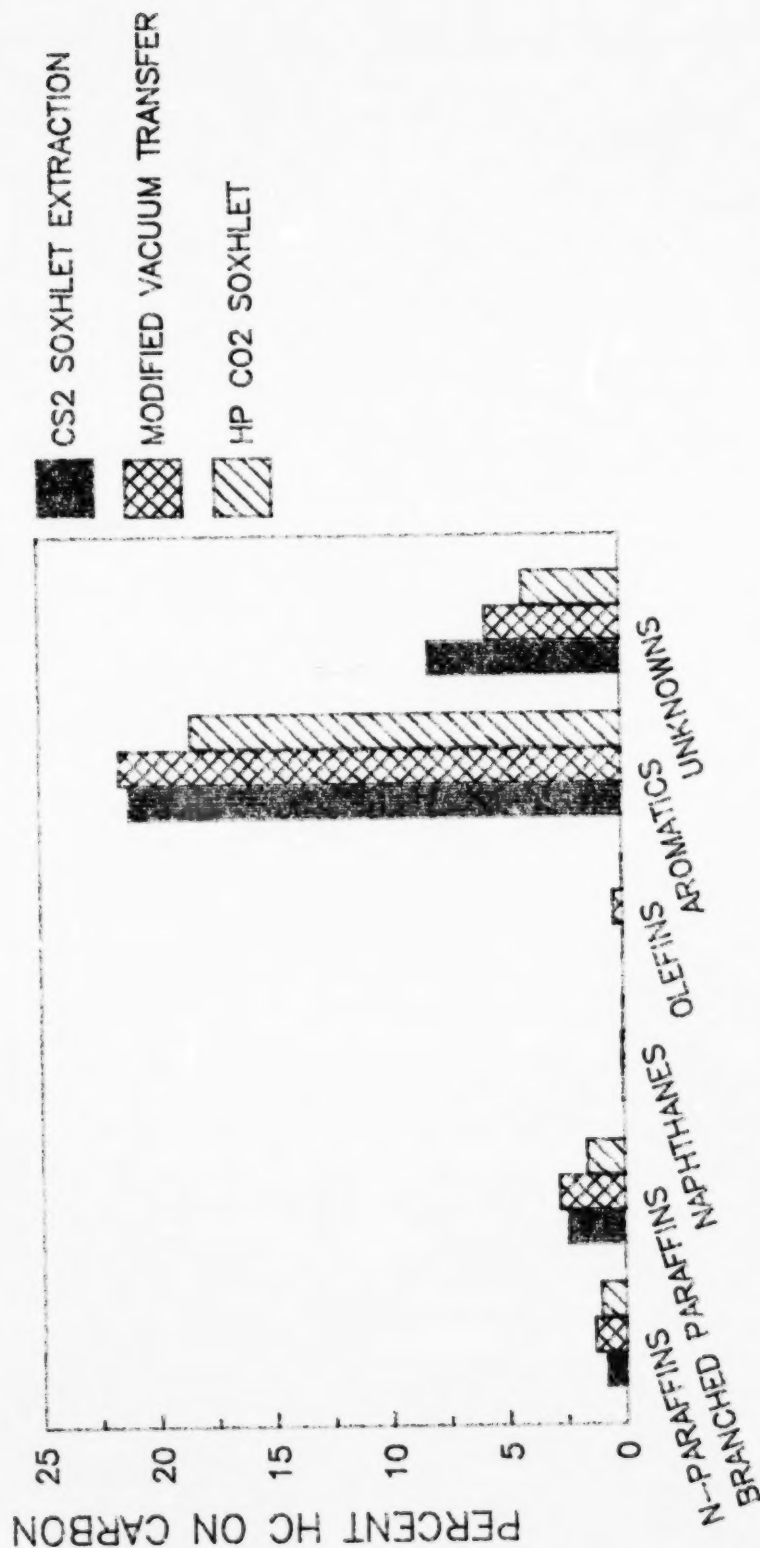
HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.00	0.00	0.01	0.02	0.01		0.20	0.80		1.04
TOTAL BRANCHED PARAFFINS	0.00	0.04	0.02	0.09	0.15	0.12	3.79	0.48		4.69
TOTAL NAPHTHANES			0.01	0.02	0.01					0.04
TOTAL OLEFINS		0.01	0.02	0.01	0.03					0.07
TOTAL AROMATICS			0.03	0.25	1.07	5.28	8.85	1.00		16.48
TOTAL UNKNOWNNS			0.00		0.03	0.24	0.70	2.23		3.21
TOTAL WT. %	0.00	0.05	0.10	0.40	1.29	5.64	13.54	4.52		25.53

COMPARISON OF CHARCOAL EXTRACTION METHODS PERCENT (BY WEIGHT) HYDROCARBON ON CARBON VS CARBON NUMBER



SAMPLE NUMBER A151/0420
DATE REMOVED 4-3-86

COMPARISON OF CHARCOAL EXTRACTION METHODS PERCENT (BY WEIGHT) HYDROCARBON ON CARBON



COMPOUND CLASS

SAMPLE NUMBER A151/0420
DATE REMOVED 4-3-86

COMPARISON OF CHARCOAL EXTRACTION METHODS

SAMPLE NUMBER A151/0320x

DATE REMOVED 3-2-86

METHODS

CLASS =====	CS2 SOXHLET EXTRACTION =====	MODIFIED VACUUM TRANSFER =====	HIGH PRESSURE CO2 SOXHLET EXTRACTION =====
TOTAL N-PARAFFINS	0.46	0.40	0.23
TOTAL BRANCHED PARAFFINS	2.01	2.33	1.34
TOTAL NAPHTHANES	0.06	0.05	0.02
TOTAL OLEFINS	0.04	0.27	0.01
TOTAL AROMATICS	10.74	8.84	7.52
TOTAL UNKNOWNNS	1.65	1.94	1.84
TOTAL % HC ON CARBON FROM GC/FID	14.96	13.43	10.97
METHOD % EXTRACTED	36.60	33.98	24.00
% MOIS.	16.40	18.60	16.40
% OF EXTRACT REPORTED BY GC/FID	88.40	94.26	>100

COMPARISON OF CHARCOAL EXTRACTION METHODS

PERCENT (BY WEIGHT) HYDROCARBON ON CARBON
BY CARBON NUMBER AND COMPOUND CLASSSAMPLE NUMBER A151/0320X
DATE REMOVED 3-2-86

CS2 SOXHLET EXTRACTION (3 HOUR EXTRACTION)

HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL N-PARAFFINS			0.01	0.03	0.04	0.09	0.17	0.10	0.03	0.46
TOTAL BRANCHED PARAFFINS			0.02	0.07	0.27	0.22	0.68	0.76		2.01
TOTAL NAPHTHANES			0.01	0.02	0.00	0.03				0.06
TOTAL OLEFINS				0.02	0.02	0.00				0.04
TOTAL AROMATICS			0.01	0.46	1.96	5.63	2.40	0.28		10.74
TOTAL UNKNOWNNS				0.01	0.01	0.04	0.49	0.51	0.60	1.65
TOTAL WT. %			0.05	0.59	2.30	6.01	3.74	1.64	0.63	14.96
% OF TOTAL			0.36	3.96	15.38	40.16	24.97	10.97	4.19	

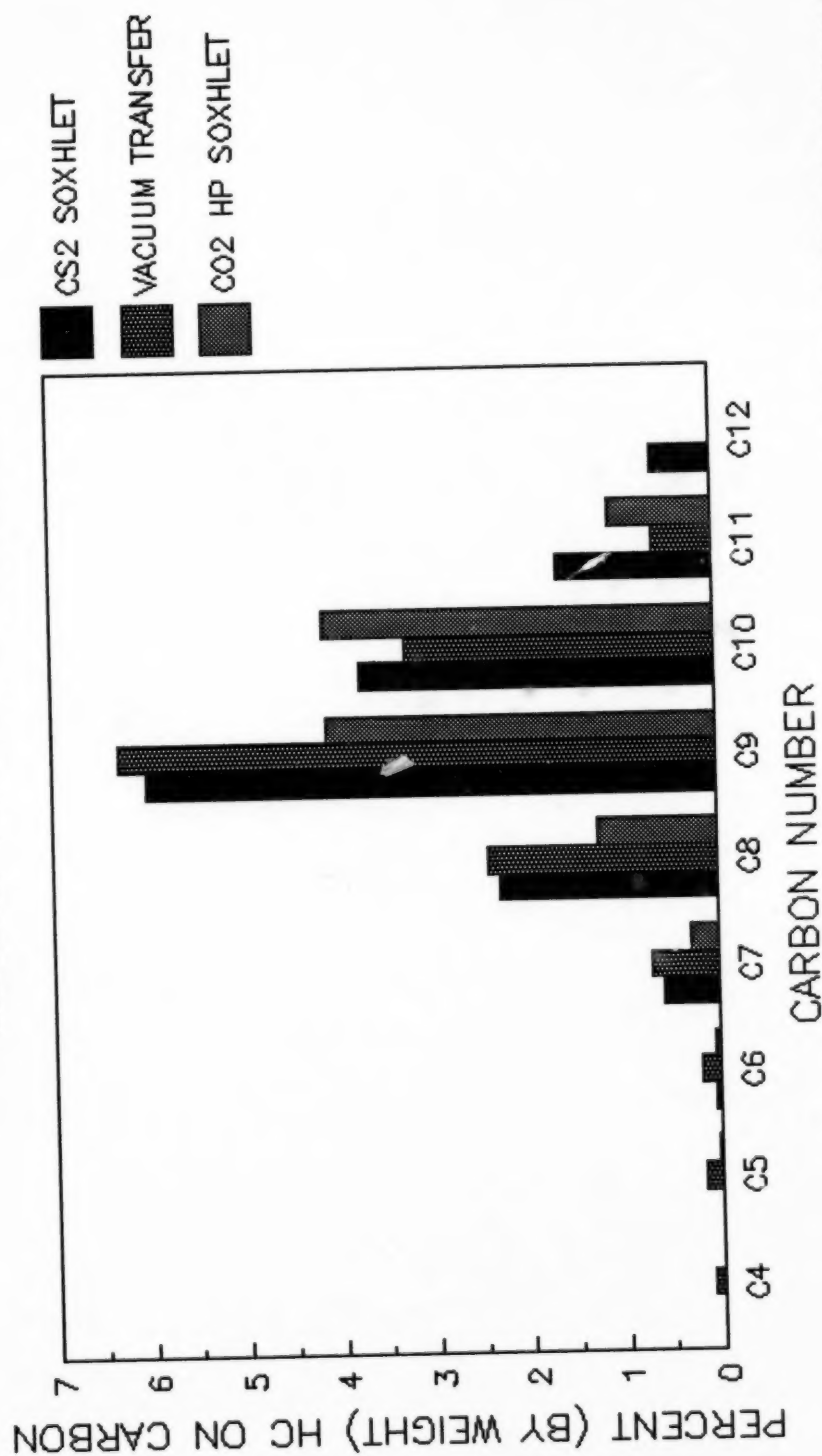
MODIFIED VACUUM TRANSFER (4 HOUR EXTRACTION)

HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL N-PARAFFINS	0.02	0.02	0.02	0.02	0.02		0.21			0.31
TOTAL BRANCHED PARAFFINS	0.01	0.05	0.05	0.12	0.32	0.30	0.76	0.16		1.77
TOTAL NAPHTHANES		0.00	0.02	0.02	0.01					0.06
TOTAL OLEFINS	0.06	0.09	0.03	0.04	0.06	0.00				0.29
TOTAL AROMATICS			0.05	0.47	1.92	5.00	1.98	0.07		9.48
TOTAL UNKNOWNNS	0.00	0.02	0.02	0.02	0.08	1.01	0.33	0.40		1.88
TOTAL WT. %	0.10	0.18	0.19	0.69	2.42	6.31	3.27	0.63		13.79
% OF TOTAL	0.69	1.34	1.35	5.03	17.54	45.79	23.71	4.55		

HIGH PRESSURE CO2 SOXHLET EXTRACTION (1 HOUR EXTRACTION)

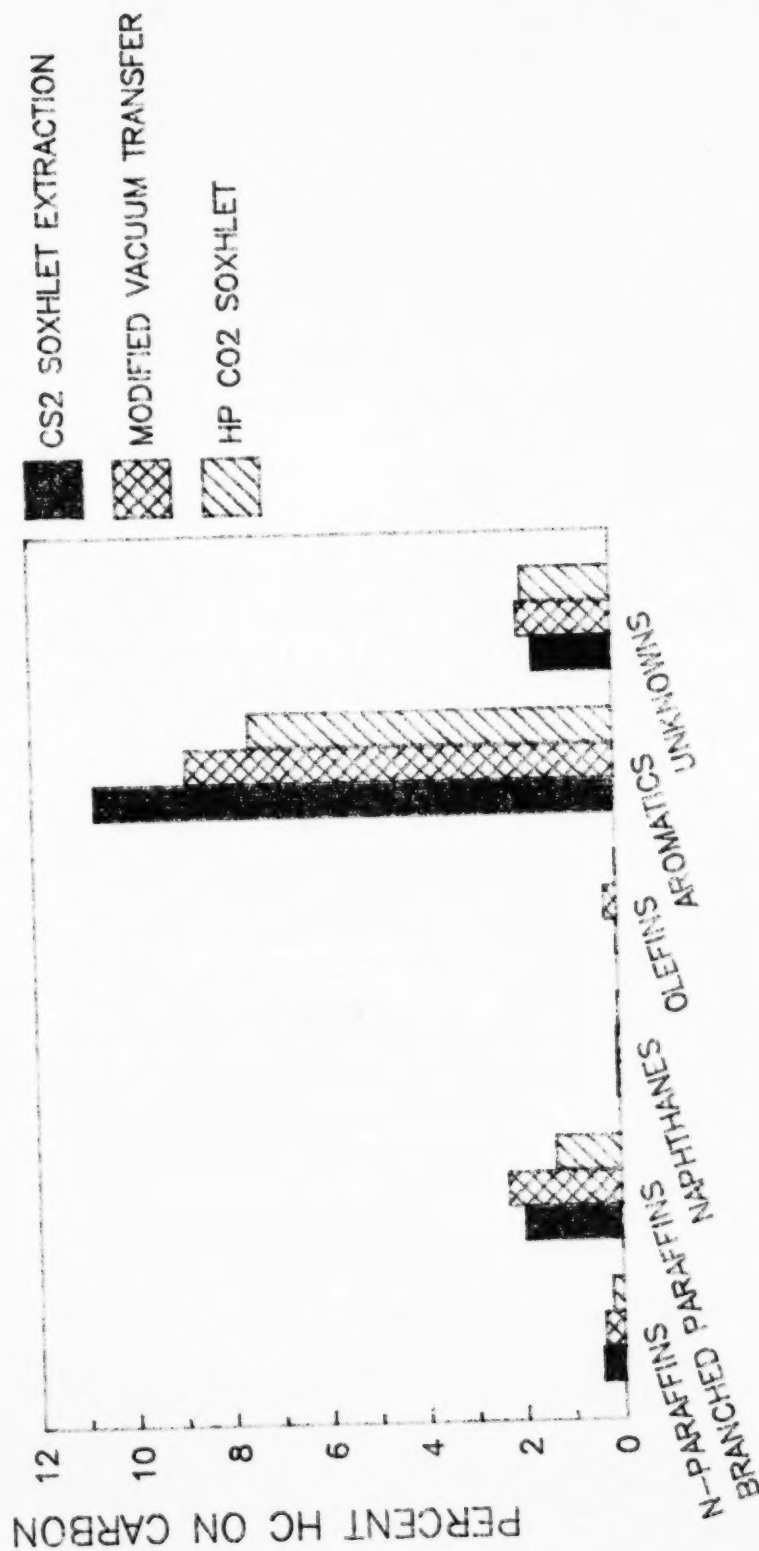
HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL N-PARAFFINS	0.00	0.00	0.01	0.02	0.00		0.13	0.03		0.20
TOTAL BRANCHED PARAFFINS	0.00	0.03	0.01	0.04	0.16	0.16	0.74	0.22		1.37
TOTAL NAPHTHANES			0.01	0.01	0.00					0.02
TOTAL OLEFINS		0.00	0.01	0.01	0.03					0.05
TOTAL AROMATICS			0.01	0.22	1.02	3.68	3.04	0.19		8.18
TOTAL UNKNOWNNS					0.04	0.28	0.21	0.64		1.16
TOTAL WT. %	0.00	0.03	0.05	0.30	1.26	4.12	4.13	1.08		10.97
% OF TOTAL	0.02	0.30	0.42	2.78	11.48	37.56	37.61	9.83		

COMPARISON OF CHARCOAL EXTRACTION METHODS PERCENT (BY WEIGHT) HYDROCARBON ON CARBON VS CARBON NUMBER



SAMPLE NUMBER A151/0320X
DATE REMOVED 3-2-86

COMPARISON OF CHARCOAL EXTRACTION METHODS PERCENT (BY WEIGHT) HYDROCARBON ON CARBON



COMPOUND CLASS

SAMPLE NUMBER A151/0320X
DATE REMOVED 3-2-86

COMPARISON OF CHARCOAL EXTRACTION METHODS

SAMPLE NUMBER A151/0282

DATE REMOVED 3-24-86

METHODS

CLASS =====	CS2 SOXHLET EXTRACTION =====	MODIFIED VACUUM TRANSFER =====	HIGH PRESSURE CO2 SOXHLET EXTRACTION =====
TOTAL N-PARAFFINS	0.55	0.87	0.37
TOTAL BRANCHED PARAFFINS	4.86	5.88	2.74
TOTAL NAPHTHANES	0.12	0.23	0.03
TOTAL OLEFINS	0.04	0.36	0.26
TOTAL AROMATICS	16.03	12.80	13.13
TOTAL UNKNOWNNS	1.27	1.01	2.29
TOTAL % HC ON CARBON FROM GC/FID	22.87	21.15	18.19
METHOD % EXTRACTED	35.20	30.40	28.2
% MOIS.	4.80	7.10	4.80
% OF EXTRACT REPORTED BY GC/FID	78.61	92.93	81.52

COMPARISON OF CHARCOAL EXTRACTION METHODS

PERCENT (BY WEIGHT) HYDROCARBON ON CARBON
BY CARBON NUMBER AND COMPOUND CLASSSAMPLE NUMBER A151/0282
DATE REMOVED 3-24-86

CS2 SOXHLET EXTRACTION (3 HOUR EXTRACTION)

HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL N-PARAFFINS			0.09	0.02	0.04	0.14	0.15	0.08	0.03	0.55
TOTAL BRANCHED PARAFFINS			0.31	0.66	2.14	0.32	0.75	0.69		4.86
TOTAL NAPHTHANES			0.06	0.02	0.00	0.04				0.12
TOTAL OLEFINS			0.01	0.02	0.02	0.00				0.04
TOTAL AROMATICS			0.01	4.26	3.05	6.10	2.35	0.27		16.04
TOTAL UNKNOWN				0.00	0.00	0.05	0.39	0.41	0.42	1.27
TOTAL WT. %			0.48	4.98	5.25	6.64	3.65	1.44	0.44	22.89
% OF TOTAL			2.09	21.77	22.93	29.01	15.95	6.31	1.94	

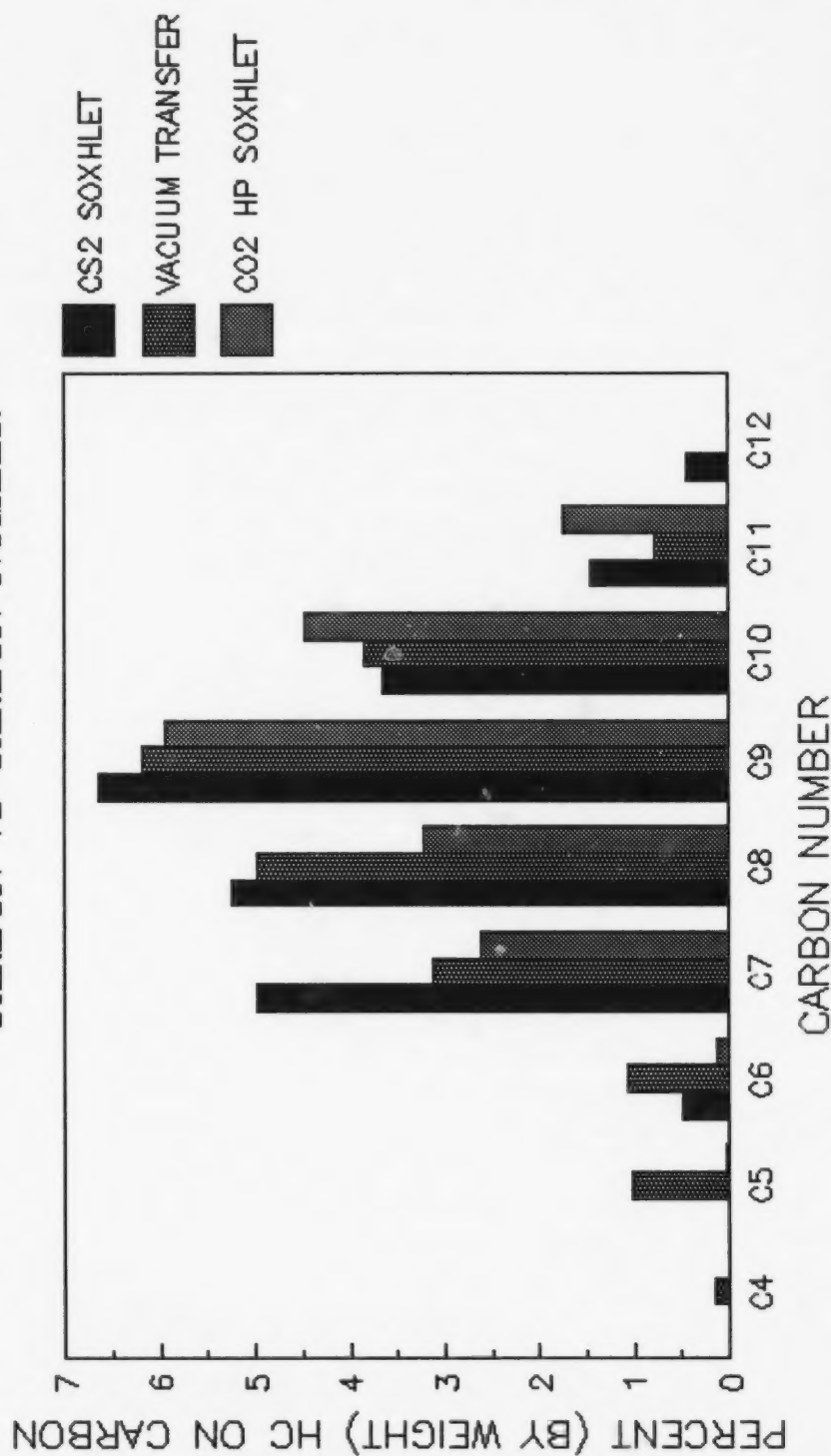
MODIFIED VACUUM TRANSFER (4 HOUR EXTRACTION)

HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL N-PARAFFINS	0.06	0.31	0.14	0.12	0.02		0.02	0.06		0.73
TOTAL BRANCHED PARAFFINS	0.04	0.47	0.60	0.97	2.22	0.58	0.69	0.20		5.77
TOTAL NAPHTHANES		0.04	0.12	0.02	0.01					0.20
TOTAL OLEFINS	0.03	0.17	0.08	0.05	0.07	0.01				0.42
TOTAL AROMATICS			0.10	1.97	2.51	5.25	2.98	0.09		12.90
TOTAL UNKNOWN		0.01	0.01	0.00	0.13	0.36	0.16	0.42		1.11
TOTAL WT. %	0.14	1.01	1.07	3.13	4.97	6.20	3.85	0.77		21.13
% OF TOTAL	0.64	4.77	5.04	14.82	23.51	29.35	18.24	3.62		

HIGH PRESSURE CO2 SOXHLET EXTRACTION (1 HOUR EXTRACTION)

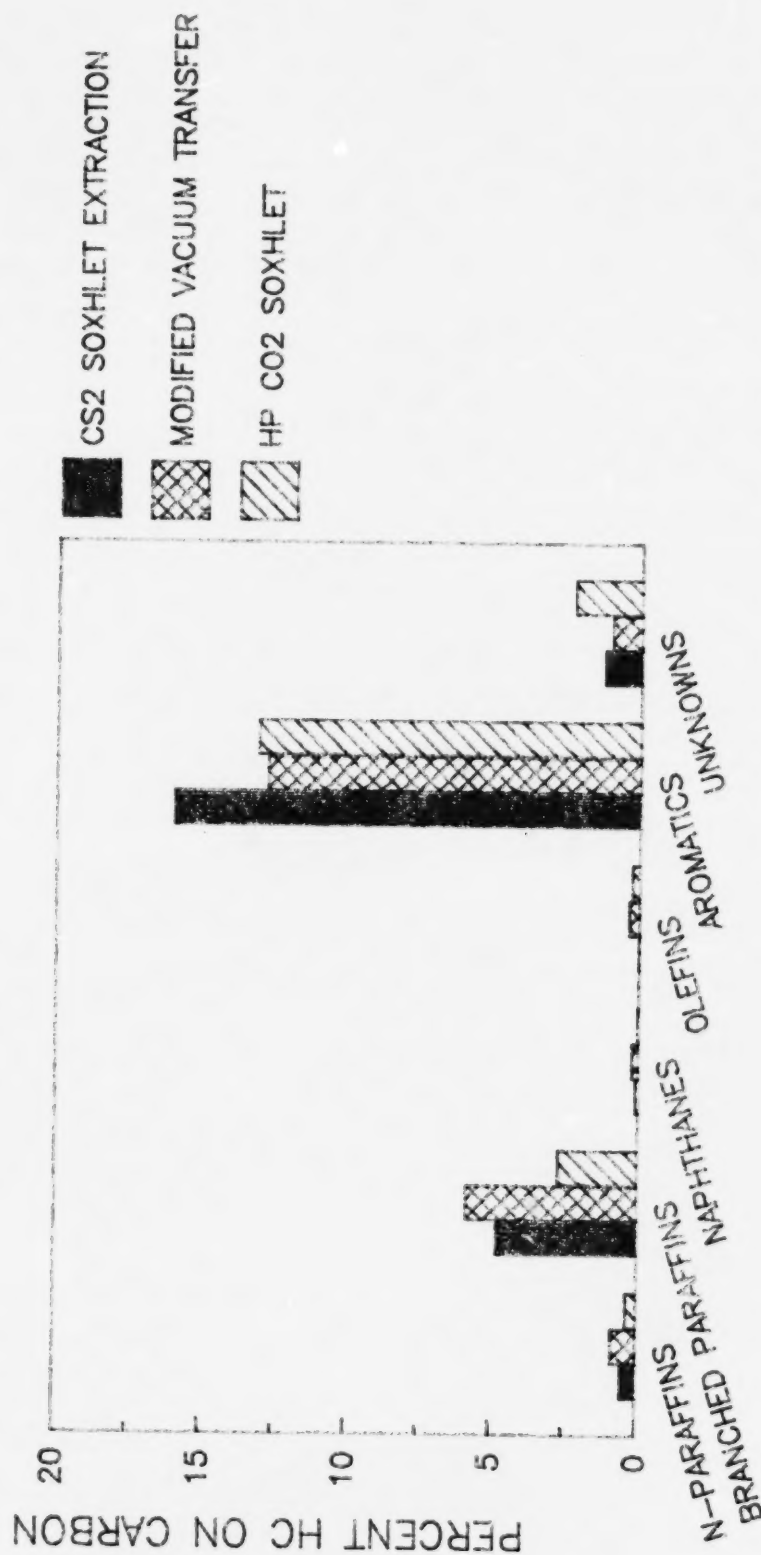
HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL N-PARAFFINS	0.00	0.00	0.02	0.01	0.00		0.16	0.09		0.30
TOTAL BRANCHED PARAFFINS	0.00	0.01	0.05	0.28	1.06	0.28	0.79	0.23		2.70
TOTAL NAPHTHANES		0.01	0.02	0.01	0.00					0.03
TOTAL OLEFINS		0.01	0.01	0.01	0.03					0.06
TOTAL AROMATICS			0.02	2.30	2.05	5.31	3.10	0.26		13.03
TOTAL UNKNOWN		0.00	0.00		0.07	0.36	0.43	1.16		2.03
TOTAL WT. %	0.00	0.03	0.12	2.61	3.22	5.95	4.48	1.73		18.14
% OF TOTAL	0.03	0.17	0.65	14.38	17.73	32.79	24.69	9.55		

COMPARISON OF CHARCOAL EXTRACTION METHODS PERCENT (BY WEIGHT) HYDROCARBON ON CARBON VS CARBON NUMBER



SAMPLE NUMBER A151/0282
DATE REMOVED 3-24-86

COMPARISON OF CHARCOAL EXTRACTION METHODS PERCENT (BY WEIGHT) HYDROCARBON ON CARBON



COMPOUND CLASS

SAMPLE NUMBER A151/0282
DATE REMOVED 3--24--86

COMPARISON OF CHARCOAL EXTRACTION METHODS

SAMPLE NUMBER A152/0599

DATE REMOVED 6-3-85

METHODS

CLASS =====	CS2 SOXHLET EXTRACTION =====	MODIFIED VACUUM TRANSFER =====	HIGH PRESSURE CO2 SOXHLET EXTRACTION =====
TOTAL N-PARAFFINS	0.98	1.10	0.44
TOTAL BRANCHED PARAFFINS	6.95	7.80	4.47
TOTAL NAPHTHANES	0.27	0.10	0.04
TOTAL OLEFINS	0.23	0.22	0.04
TOTAL AROMATICS	6.70	5.71	4.57
TOTAL UNKNOWNNS	0.31	0.69	0.74
TOTAL % HC ON CARBON FROM GC/FID	15.39	15.63	10.31
METHOD % EXTRACTED	25.60	19.40	17.80
% MOIS.	0.80	0.10	0.80
% OF EXTRACT REPORTED BY GC/FID	63.33	80.57	57.92

COMPARISON OF CHARCOAL EXTRACTION METHODS

PERCENT (BY WEIGHT) HYDROCARBON ON CARBON
BY CARBON NUMBER AND COMPOUND CLASSSAMPLE NUMBER A152/0599
DATE REMOVED 6-3-85

CS2 SOXHLET EXTRACTION (3 HOUR EXTRACTION)

HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL N-PARAFFINS			0.13	0.27	0.36	0.12	0.07	0.03	0.01	0.98
TOTAL BRANCHED PARAFFINS			0.35	0.75	4.55	0.61	0.47	0.24		6.96
TOTAL NAPHTHANES			0.05	0.03	0.13	0.06				0.27
TOTAL OLEFINS			0.02	0.06	0.14	0.01				0.24
TOTAL AROMATICS			0.00	1.43	1.79		0.84			6.60
TOTAL UNKNOWN				0.00	0.07	0.03	0.06	0.08	0.06	0.31
TOTAL WT. %			0.56	2.54	7.04	3.37	1.44	0.35	0.07	15.37
% OF TOTAL			3.62	16.52	45.78	21.94	9.36	2.31	0.47	

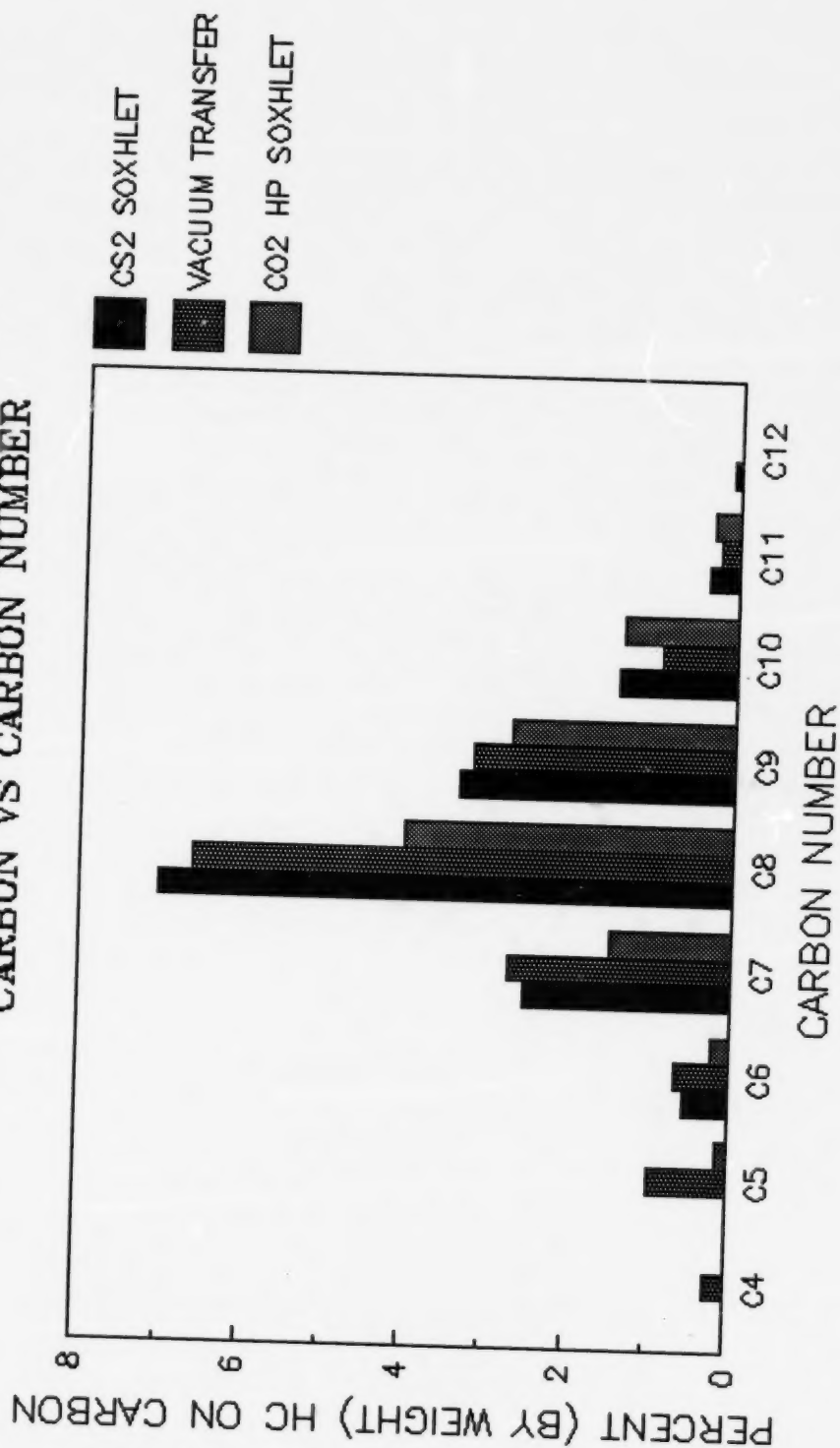
MODIFIED VACUUM TRANSFER (4 HOUR EXTRACTION)

HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL N-PARAFFINS	0.21	0.31	0.13	0.30	0.03		0.04	0.04		1.06
TOTAL BRANCHED PARAFFINS	0.02	0.51	0.37	0.88	4.38	0.74	0.24	0.04		7.17
TOTAL NAPHTHANES		0.02	0.06	0.03	0.04					0.15
TOTAL OLEFINS	0.03	0.10	0.05	0.05	0.39					0.63
TOTAL AROMATICS			0.06	1.48	1.69	2.12	0.57	0.02		5.94
TOTAL UNKNOWN	0.00	0.02	0.02	0.01	0.10	0.34	0.06	0.13		0.68
TOTAL WT. %	0.26	0.97	0.67	2.74	6.64	3.20	0.92	0.22		15.62
% OF TOTAL	1.68	6.21	4.30	17.53	42.48	20.48	5.89	1.43		

HIGH PRESSURE CO2 SOXHLET EXTRACTION (1 HOUR EXTRACTION)

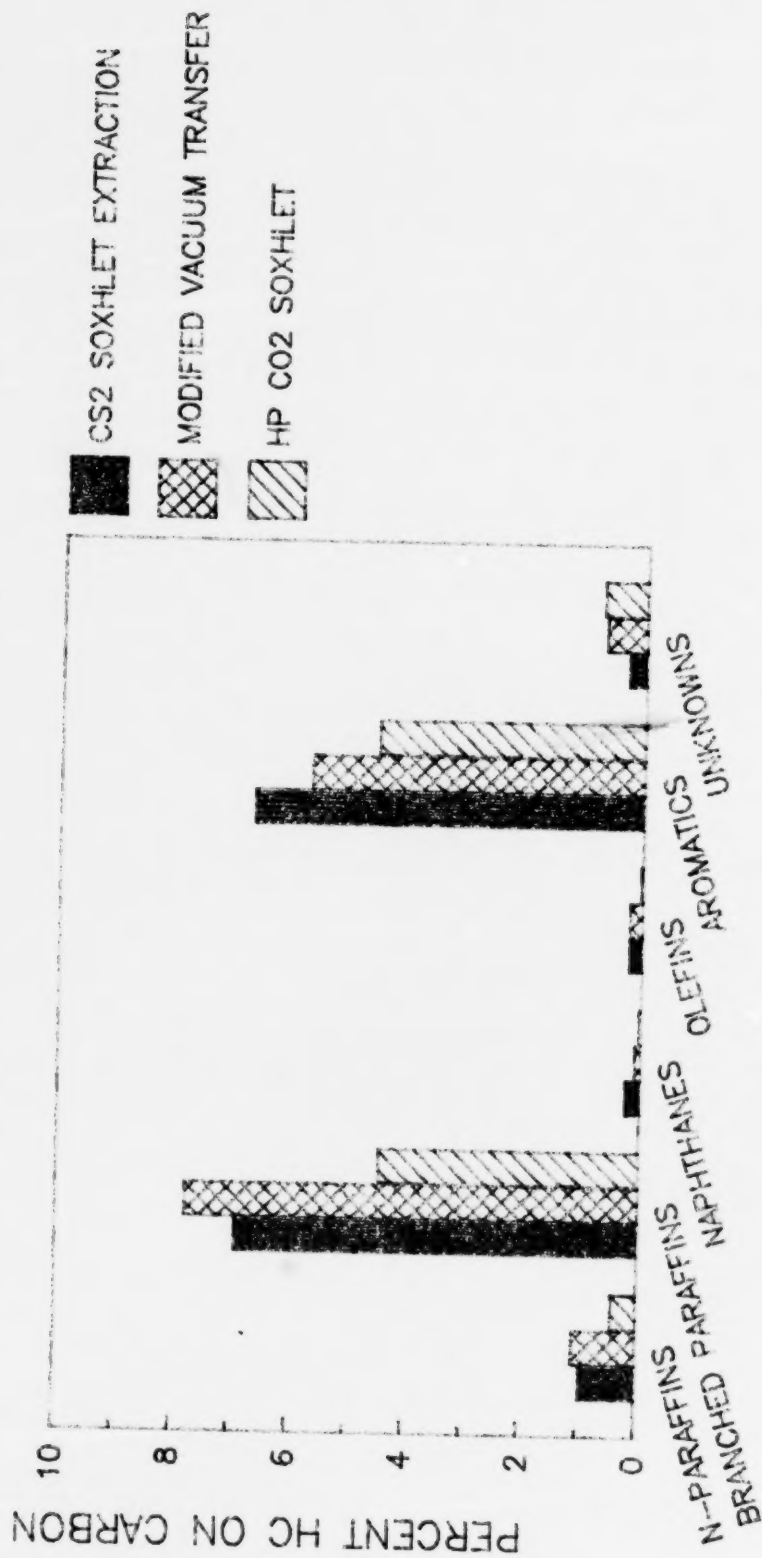
HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL N-PARAFFINS	0.00	0.05	0.04	0.18	0.02		0.06	0.04		0.40
TOTAL BRANCHED PARAFFINS	0.00	0.06	0.11	0.42	2.57	0.61	0.32	0.09		4.18
TOTAL NAPHTHANES		0.00	0.02	0.01	0.03					0.07
TOTAL OLEFINS		0.01	0.02	0.03	0.28					0.34
TOTAL AROMATICS			0.01	0.85	1.05	1.79	0.88	0.05		4.64
TOTAL UNKNOWN		0.01	0.00	0.00	0.09	0.34	0.11	0.12		0.68
TOTAL WT. %	0.00	0.13	0.21	1.49	4.04	2.74	1.38	0.30		10.31

COMPARISON OF CHARCOAL EXTRACTION METHODS PERCENT (BY WEIGHT) HYDROCARBON ON CARBON VS CARBON NUMBER



SAMPLE NUMBER A152/0599
DATE REMOVED 6-3-85

COMPARISON OF CHARCOAL EXTRACTION METHODS PERCENT (BY WEIGHT) HYDROCARBON ON CARBON



SAMPLE NUMBER A152/0599
DATE REMOVED 6-3-85

COMPARISON OF CHARCOAL EXTRACTION METHODS

SAMPLE NUMBER Gasoline (Base)

DATE REMOVED NA

METHODS

CLASS =====	CS2 SOXHLET EXTRACTION =====	MODIFIED VACUUM TRANSFER =====	HIGH PRESSURE CO2 SOXHLET EXTRACTION =====
TOTAL N-PARAFFINS	0.75	1.02	NM
TOTAL BRANCHED PARAFFINS	8.23	7.39	"
TOTAL NAPHTHANES	0.40	0.38	"
TOTAL OLEFINS	0.47	1.48	"
TOTAL AROMATICS	4.75	3.11	"
TOTAL UNKNOWNNS	0.41	0.44	"
TOTAL % HC ON CARBON FROM GC/FID	15.01	13.82	-
METHOD % EXTRACTED	22.40	21.40	14.30
% MOIS.	4.60	5.80	
% OF EXTRACT REPORTED BY GC/FID	87.54	91.68	-

1- NM = Not Measured

COMPARISON OF CHARCOAL EXTRACTION METHODS

PERCENT (BY WEIGHT) HYDROCARBON ON CARBON
BY CARBON NUMBER AND COMPOUND CLASS

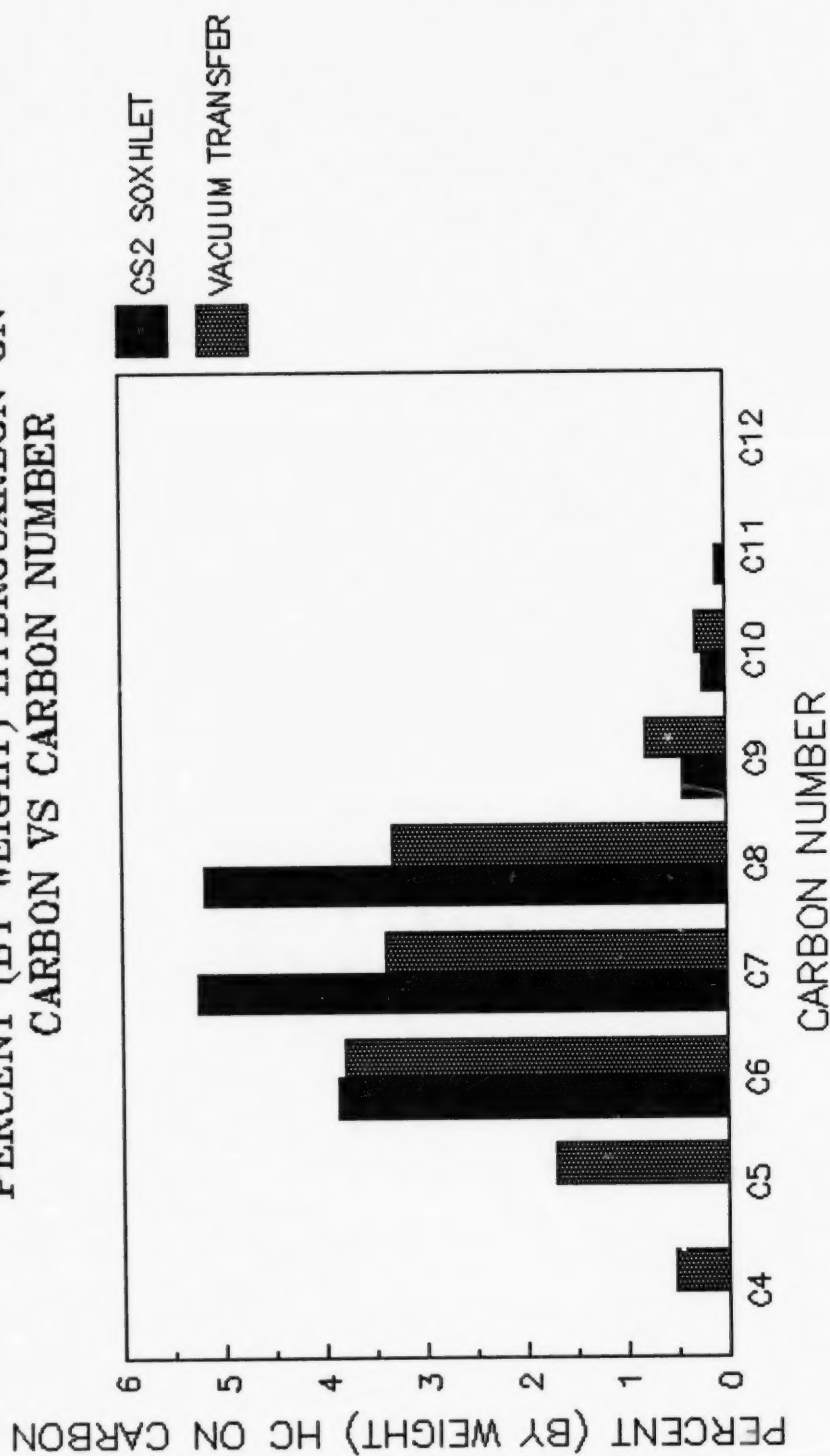
SAMPLE NUMBER Gasoline (base) CS2 SOXHLET EXTRACTION (3 HOUR EXTRACTION)
DATE REMOVED NA

HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL N-PARAFFINS			0.44	0.17	0.05	0.03		0.05		0.74
TOTAL BRANCHED PARAFFINS		2.26	1.61	4.14	0.07	0.14	0.04			8.26
TOTAL NAPHTHANES		0.22	0.16	0.03						0.41
TOTAL OLEFINS		0.33	0.12	0.02						0.47
TOTAL AROMATICS		0.42	3.10	0.87	0.28	0.07	0.00			4.75
TOTAL UNKNOWNNS		0.17	0.09	0.09	0.05					0.40
TOTAL WT. %		3.86	5.25	5.20	0.43	0.21	0.09	0.00		15.04
% OF TOTAL			25.65	34.91	34.59	2.84	1.39	0.63		

MODIFIED VACUUM TRANSFER (4 HOUR EXTRACTION)

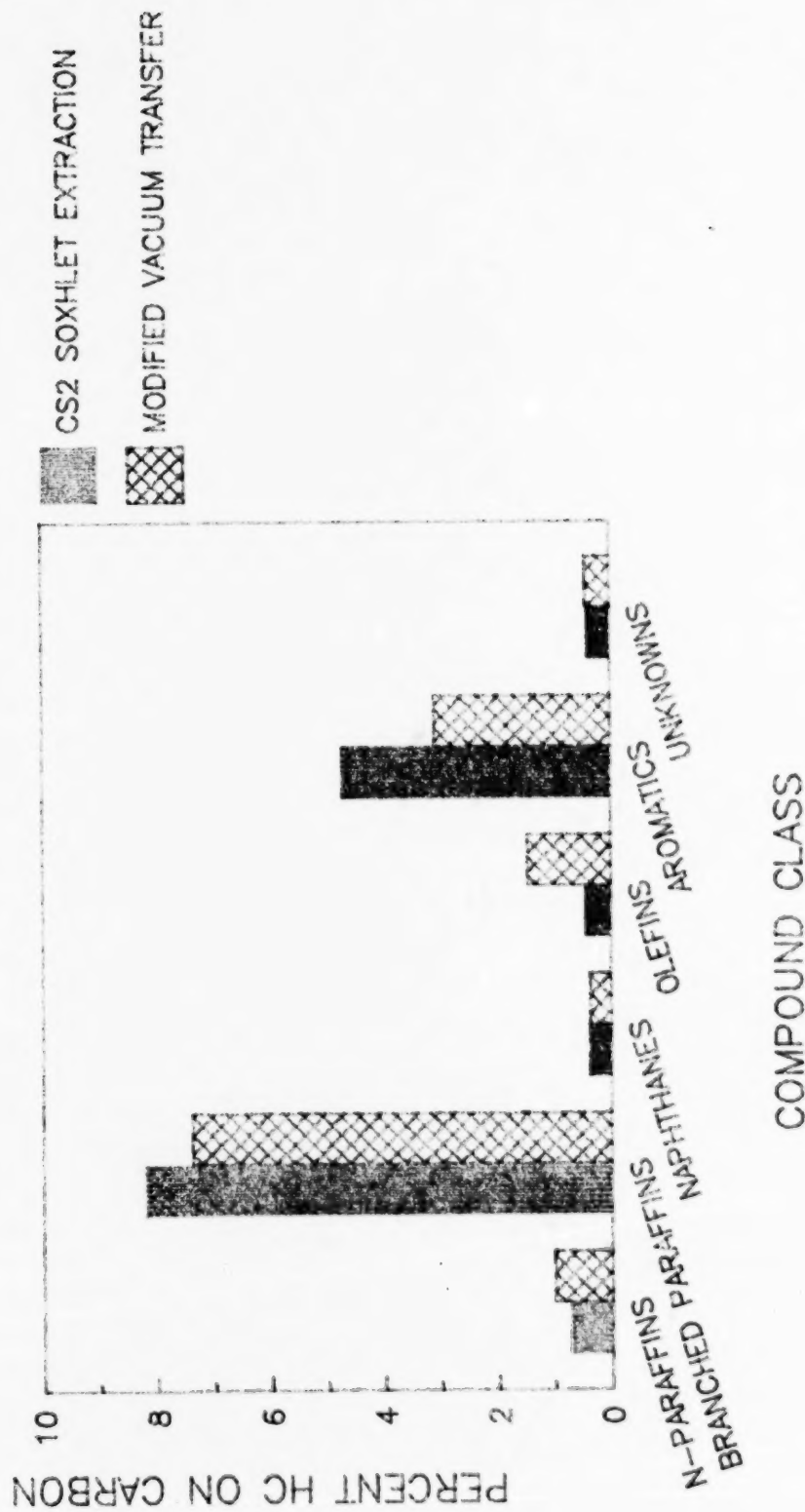
HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL N-PARAFFINS		0.09	0.31	0.41	0.19	0.01	0.01			1.02
TOTAL BRANCHED PARAFFINS	0.18	0.76	1.94	1.78	2.50	0.19	0.03	0.00		7.39
TOTAL NAPHTHANES		0.02	0.28	0.08						0.38
TOTAL OLEFINS	0.24	0.61	0.56	0.01	0.05					1.48
TOTAL AROMATICS			0.41	1.28	0.74	0.59	0.09			3.11
TOTAL UNKNOWNNS		0.00	0.21	0.04	0.03	0.00	0.16			0.44
TOTAL WT. %	0.51	1.70	3.80	3.39	3.33	0.79	0.29	0.00		13.82
% OF TOTAL	3.67	12.34	27.54	24.51	24.14	5.69	2.08	0.03		

COMPARISON OF CHARCOAL EXTRACTION METHODS PERCENT (BY WEIGHT) HYDROCARBON ON CARBON VS CARBON NUMBER



SAMPLE NUMBER GASOLINE (BASE)
DATE REMOVED NA

COMPARISON OF CHARCOAL EXTRACTION METHODS PERCENT (BY WEIGHT) HYDROCARBON ON CARBON



SAMPLE NUMBER GASOLINE (BASE)
DATE REMOVED NA

COMPARISON OF CHARCOAL EXTRACTION METHODS

SAMPLE NUMBER Gasoline (Blend)

DATE REMOVED NA

METHODS

CLASS =====	CS2 SOXHLET EXTRACTION =====	MODIFIED VACUUM TRANSFER =====	HIGH PRESSURE CO2 SOXHLET EXTRACTION =====
TOTAL N-PARAFFINS	0.45	0.42	0.23
TOTAL BRANCHED PARAFFINS	6.36	6.21	3.63
TOTAL NAPHTHANES	0.17	0.12	0.05
TOTAL OLEFINS	0.19	0.33	0.09
TOTAL AROMATICS	4.52	3.66	2.47
TOTAL UNKNOWNNS	0.21	0.17	0.22
TOTAL % HC ON CARBON FROM GC/FID	11.90	10.90	6.69
METHOD % EXTRACTED	20.85	18.20	19.70
% MOIS.	5.60	5.80	5.60
% OF EXTRACT REPORTED BY GC/FID	83.93	91.76	62.39

COMPARISON OF CHARCOAL EXTRACTION METHODS

PERCENT (BY WEIGHT) HYDROCARBON ON CARBON
BY CARBON NUMBER AND COMPOUND CLASS

SAMPLE NUMBER Gasoline (blend) CS2 SOXHLET EXTRACTION (3 HOUR EXTRACTION)
DATE REMOVED NA

HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL N-PARAFFINS			0.23	0.15	0.05	0.01				0.45
TOTAL BRANCHED PARAFFINS			0.70	1.19	4.23	0.23	0.02	0.01		6.37
TOTAL NAPHTHANES			0.04	0.10	0.03					0.17
TOTAL OLEFINS			0.09	0.09	0.01					0.19
TOTAL AROMATICS			0.13	2.97	0.99	0.39	0.03	0.00		4.52
TOTAL UNKNOWN			0.02	0.07	0.11	0.00	0.00	0.01		0.22
TOTAL WT. %			1.22	4.56	5.43	0.64	0.05	0.02		11.92
% OF TOTAL			10.27	38.22	45.51	5.39	0.46	0.15		

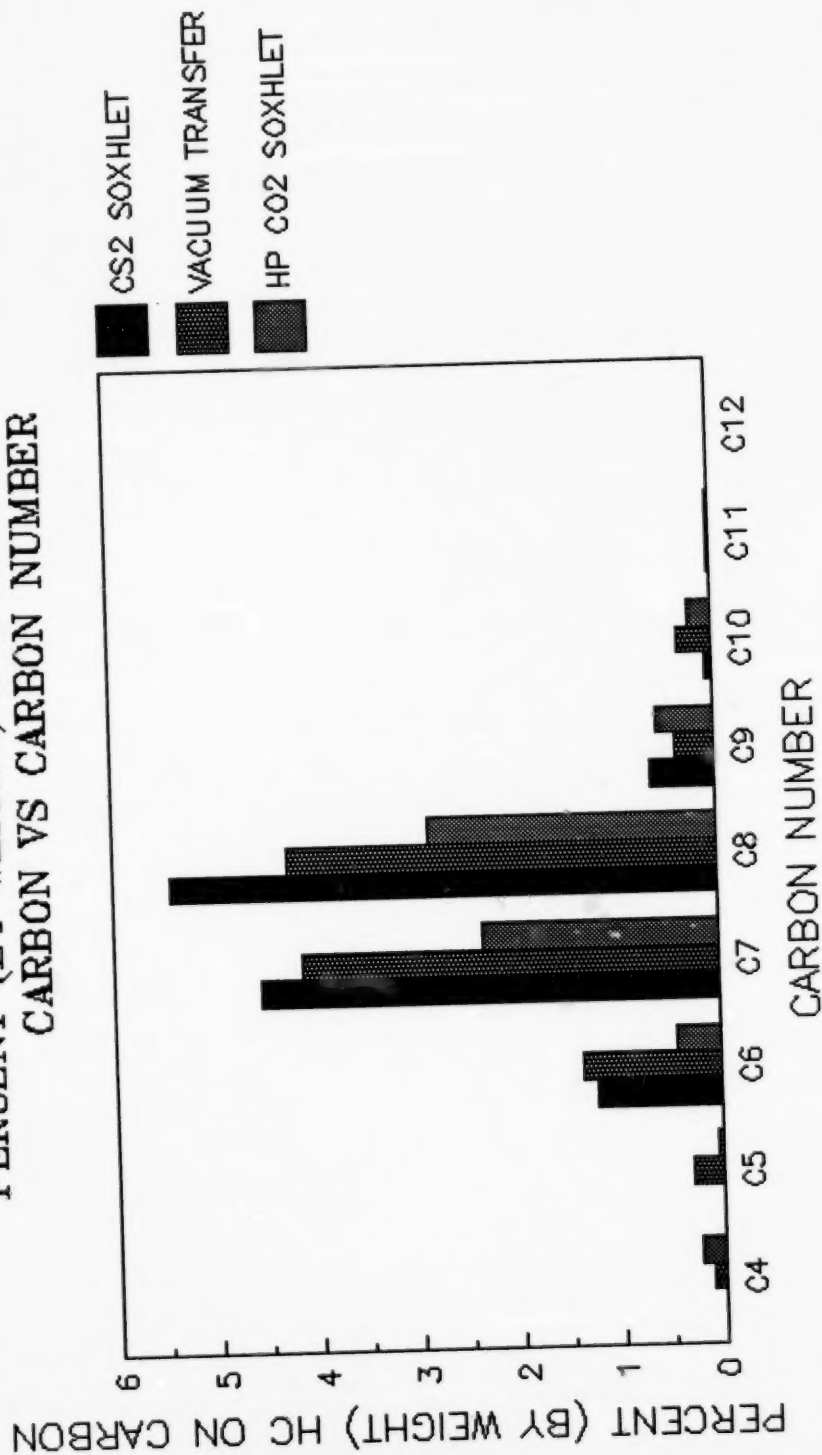
MODIFIED VACUUM TRANSFER (4 HOUR EXTRACTION)

HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL N-PARAFFINS	0.02	0.03	0.19	0.15	0.01	0.01	0.00	0.00		0.42
TOTAL BRANCHED PARAFFINS	0.06	0.08	0.81	1.33	3.51	0.18	0.23	0.00		6.21
TOTAL NAPHTHANES		0.00	0.07	0.05						0.12
TOTAL OLEFINS	0.02	0.18	0.09	0.01	0.03					0.33
TOTAL AROMATICS			0.18	2.55	0.71	0.17	0.06			3.66
TOTAL UNKNOWN		0.00	0.03	0.05	0.02	0.02	0.05			0.17
TOTAL WT. %	0.11	0.29	1.36	4.14	4.28	0.37	0.34	0.01		10.90
% OF TOTAL	0.97	2.70	12.48	38.00	39.25	3.41	3.13	0.05		

HIGH PRESSURE CO2 SOXHLET EXTRACTION (1 HOUR EXTRACTION)

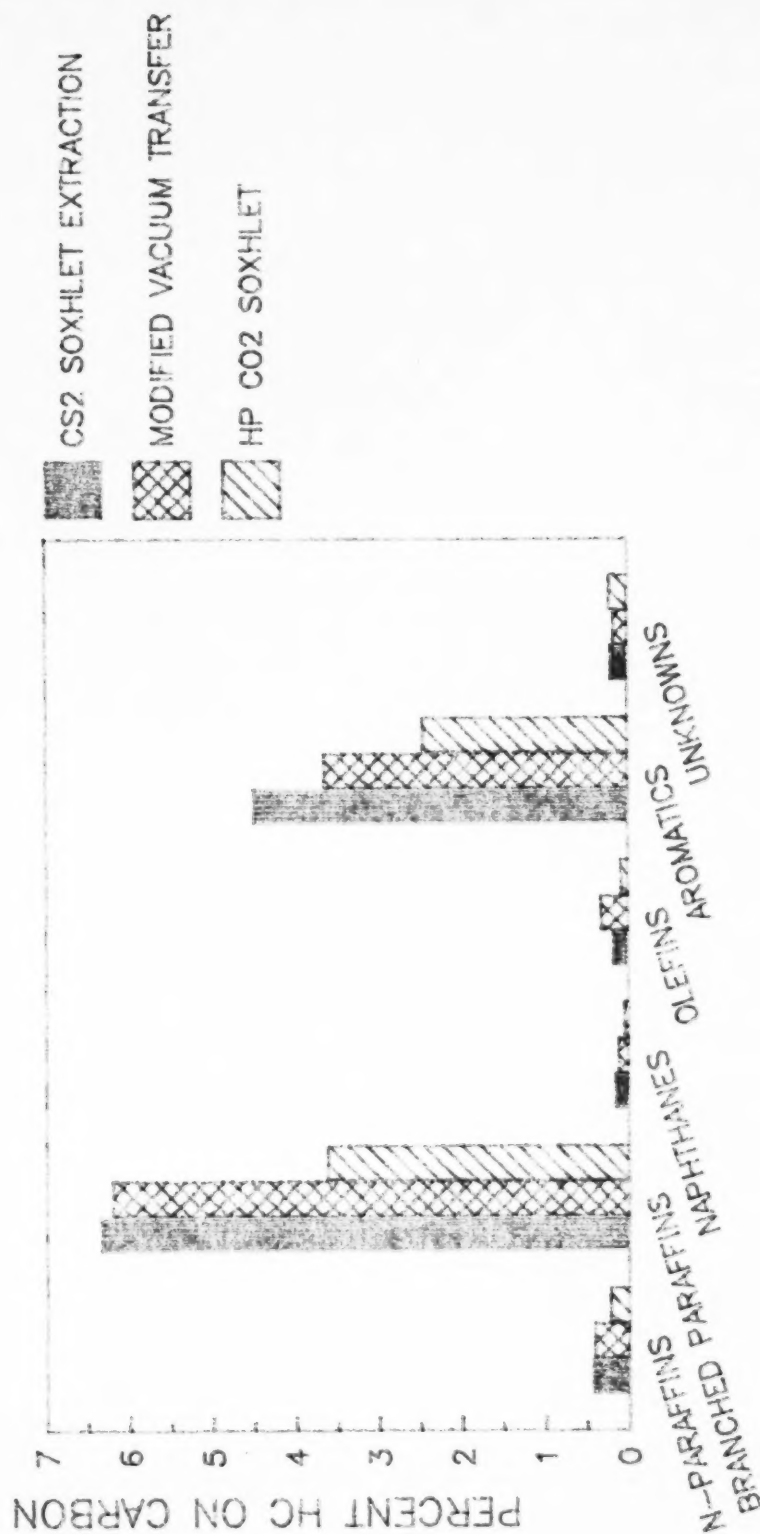
HC CLASS	C4	C5	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
TOTAL N-PARAFFINS	0.01	0.00	0.06	0.14	0.00	0.01	0.01			0.23
TOTAL BRANCHED PARAFFINS	0.20	0.01	0.21	0.67	2.30	0.17	0.05	0.01		3.63
TOTAL NAPHTHANES		0.00	0.02	0.02						0.05
TOTAL OLEFINS		0.01	0.04	0.02	0.02					0.09
TOTAL AROMATICS			0.06	1.49	0.53	0.30	0.09			2.47
TOTAL UNKNOWN			0.03	0.01	0.01	0.09	0.08			0.22
TOTAL WT. %	0.22	0.03	0.43	2.35	2.87	0.57	0.22	0.01		6.69
% OF TOTAL	3.23	0.40	6.41	35.10	42.89	8.52	3.32	0.12		

COMPARISON OF CHARCOAL EXTRACTION METHODS PERCENT (BY WEIGHT) HYDROCARBON ON CARBON VS CARBON NUMBER



SAMPLE NUMBER GASOLINE (BLEND)
DATE REMOVED NA

COMPARISON OF CHARCOAL EXTRACTION METHODS PERCENT (BY WEIGHT) HYDROCARBON ON CARBON



COMPOUND CLASS

SAMPLE NUMBER GASOLINE (BLEND)
DATE REMOVED NA